SCIENTIFIC AMERICAN SUPPLEMENT No. 425

Scientific American Supplement, Vol. XVII., No. 425. Scientific American, established 1845.

NEW YORK, FEBRUARY 23, 1884.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

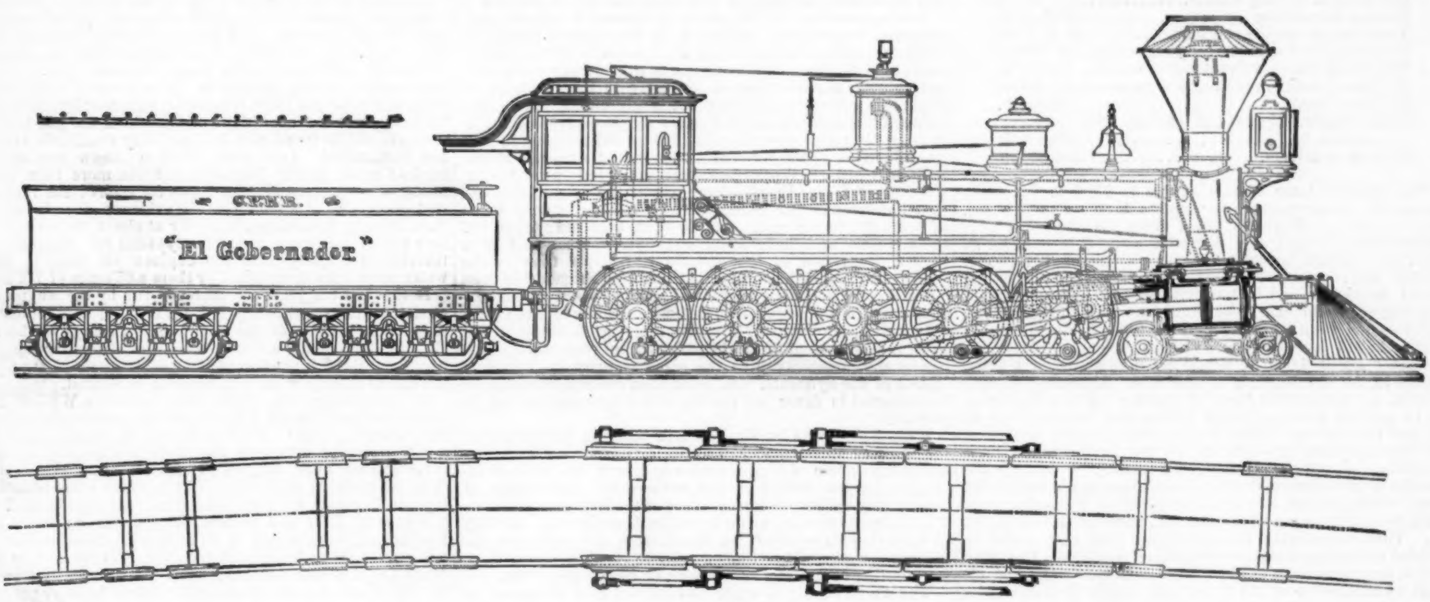
NEW RAILWAY STATIONS, MELBOURNE.

OUR engravings illustrate the accepted designs for the new railway stations, Melbourne, Victoria, Australia. These buildings are indicative of the rapid progress that the enterprising colony of Victoria is making. Among existing specimens of railway architecture it would be difficult to find any buildings that present a more pleasing appearance than this far-away southern example.

"EL GOBERNADOR."

WE publish this week illustrations of an enormous engine now being built by the Central Pacific Railroad, at its shops at Sacramento, Cal. This engine is designed to work the inclines by which the Southern Pacific Railroad crosses the slopes of the Sierra Nevada mountains. Its immense size fairly justifies the title of El Gobernador, which, we presume, is polite Spanish for "The Boss."

A somewhat similar but smaller engine (Mastodon) was exhibited at Chicago last year, but this engine differs from that in having ten instead of eight wheels coupled, and in having an improved and simplified form of valve gear. The Mastodon had four valves to each cylinder, two main valves, and two riding cut-off valves, worked by three eccentrics, and deriving also some motion from the cross-head. In El Gobernador this arrangement has been simplified and improved, and but two valves and one eccentric are



EL GOBERNADOR, THE MOST POWERFUL LOCOMOTIVE IN THE WORLD.

THE NEW RAILWAY STATIONS, MELBOURNE, VICTORIA, AUSTRALIA.

used for the valve motion of each cylinder. The opening of the port is given by the eccentric, and the lap and lead are derived from the engine cross head.

As far as can be judged from a model the distribution effected by this valve gear is excellent. The valve opens sharply for admission, until the port is wide open, then remains almost stationary, and finally closes again with great rapidity. One valve is used at each end of the cylinder, as will be seen from the drawing, each valve being actuated by a separate spindle. The travel and cut-off can be varied by moving a die block along a curved link pivoted on a fixed center. This link is made to oscillate by means of a single long eccentric rod. The amount of motion given by the eccentric determines the opening of the port, and the lap and lead, which are invariable, are given by the motion of the cross head. This gear is the invention of Mr. A. J. Stevens, the General Master Mechanic of the Central Pacific Railroad, under whose superintendence the engine is now being built. We hope at some future time to give drawings and further particulars of this valve gear.

The leading dimensions of the engine are as follows:

Diameter of cylinders	21 in.
Stroke of cylinders	36 in.
Diameter of driving wheels	57 in.
Driving wheel base	19 ft. 7 in.
Total length, engine and tender	65 ft. 5 in.
Total weight of engine, ready for service,	146,000 lb.
Weight of tender, without coal or water	50,650 lb.
Weight of water in tank (3,600 gallons)	30,000 lb.
Weight of coal	10,000 lb.
Total weight, engine and tender, fully equipped	226,650 lb.
Weight on drivers	128,000 lb.

The tractive force of this engine is 278·6 lb. for every pound of average pressure per square inch on the pistons. Some indicator diagrams taken from the Mastodon were exhibited at Chicago, and showed at a speed of 8 miles an hour an average pressure on the pistons of 124 lb. per square inch. Assuming that a similar average pressure could be maintained in the cylinders of El Gobernador, this engine would exert the enormous pull of 34,546 lb., less loss due to its gravity and internal friction. On an incline of 116 ft. to the mile, on which the engine is to work, probably about 6,000 lb. would be thus absorbed, leaving 28,500 lb. for the traction of the cars. Assuming friction at 4 lb. per ton and the force of gravity on that incline at 44 lb. per ton, the cars would have a total resistance of 48 lb. per ton, and as 28,500 ÷ 48 = 594, the total weight of the cars which could be drawn up the incline under these conditions would be 594 tons. Deducting 10 tons for the weight of the caboose, the cars themselves would weigh 584 tons, which is equal to a train composed of 28 loaded cars, each weighing empty 21,500 lb., and each laden with 20,000 lb. This is probably the maximum load that could be hauled under the favorable conditions assumed. The Mastodon has conveyed a train of 20 loaded cars weighing 422 tons up the incline of 116 ft. per mile, and as El Gobernador is a more powerful engine, it will probably draw a proportionally heavier train.

In order to convey an idea of the relative size of El Gobernador as compared with other large engines a table is subjoined, giving a few leading dimensions of some of the largest engines, both in this country and in Europe. It will be noticed that El Gobernador possesses more tractive power and has more weight on the drivers than any of the other engines, though it would probably not be so severe on the track as the less weighty and powerful French and Swiss engines, which concentrate a very heavy load on a short wheel base. These engines, moreover, have no truck, and the leading drivers have consequently to guide the engine and bear the pitching motion due to the overhanging cylinders. It is somewhat surprising to find that the English engine, though the most powerful tender engine in use in Great Britain, is the least powerful and lightest on the track of any of the typical large engines we have selected. This probably arises from the fact that freight trains are lighter and are run at a higher speed there than in any other country. The engine in question runs at about 20 miles an hour, including stops, and works a maximum grade against the load of 39 ft. to the mile, while all the other engines are designed to ascend long mountain inclines of 100 ft. or more to the mile.

The engine for the Northern Pacific Railroad was constructed by the Baldwin Locomotive Works, and was exhibited at the Chicago Railway Exposition last year. It is somewhat heavier than is usual for engines of this class, having an extra amount of heating surface in order to make steam when burning lignite or inferior coal. The engine for working the St. Gothard Tunnel was constructed by Messrs. T. A. Maffei, of Munich, Germany. The French engine is fitted with piston valves worked by Walschaert's valve gear.

	So. Pacific.	So. Pacific.	No. Pacific.	St Gothard (Switzerland).	State France).	Great Eastern (England).
Type of engine	El Gobernador.	Mastodon.	Consolidation.	Eight connected.	Eight connected.	Mogul.
Cylinders, dia. and stroke, inch	21 × 36	20 × 30	20 × 24	20⅛ × 24	21¼ × 26	19 × 26
Drivers, dia. in.	57	56	49	46	50	58
Weight on drivers, lb.	128,000	102,700	97,000	114,240	117,505	85,300
Tractive force per lb. average pressure in cylinders, lb.	278·6	226·4	196·0	218 4	234·5	161·8
Maximum boiler pressure, lb. per sq. in.	....	135	130	147	132	140
Wheel base drivers	19 ft. 7 in.	15 ft. 9 in.	14 ft.	12 ft. 9⅛ in.	13 ft. 3⅛ in.	15 ft. 9 in.
Weight on rails per foot of driving wheel base	6,537	6,517	6,929	8,933	8,841	5,415

These figures enable an approximate idea to be formed as to the relative power of these engines, but it must be borne in mind that the late cut-off and small amount of compression given by Mr. Stevens' valve gear gives a higher average pressure on the pistons than is possible in the European engines. An average pressure on the piston of 100 to 110 lb. to the square inch is about the maximum possible, with the 70 to 77 per cent. maximum cut-off adopted there; whereas indicator cards taken on the Mastodon show an average pressure of no less than 124 lb. to the square inch. Taking this into account, El Gobernador can probably exert 50 per cent. more tractive force than the St. Gothard or French engine. This would appear to amply vindicate its claim to be considered the most powerful engine in the world.—*Railroad Gazette.*

THE INJECTOR HYDRANT FOR FIRE EXTINCTION.*

By J. H. GREATHEAD.

FROM the contributions of the fire offices toward the maintenance of the Fire Brigade, it is possible to arrive at the amount of property insured in the metropolis. In 1882 its value was 657 millions sterling. Mr. Lovell, secretary of the Phœnix Fire Office and chairman of the London Salvage Corps, stated in his evidence before the Select Committee on the Fire Brigade in 1876, that the average rate charged for insurance in the metropolis was about 3s. 6d. per cent. At this rate the premiums paid in 1882 for insurance against fire in the metropolis amounted to considerably over 1,000,000*l.* sterling.

From such of the accounts of the fire offices as are published it appears that in 1881 the average losses amounted to about 65 per cent. of the premium receipts. Mr. Lovell further stated in his evidence that the loss rate in London was higher than it was anywhere else. But assuming it to be only equal to the general average of 1881, it follows that the value of insured property destroyed by fire in the metropolis in 1882 was about three-quarters of a million sterling. But the amount of property destroyed was not all insured.

Taking one-third of the whole as insured it follows that property, insured and uninsured, to the value of about 2¼ millions sterling was destroyed in London in 1882 by fire, a sum equal to about eighteenpence in the pound on the present ratable annual value of property in the metropolis. And this enormous indirect tax is a growing one. The value of the property insured has risen steadily and rapidly from 316 millions sterling in 1866 to 657 millions in 1882 or an increase of 106 per cent. in the period since the Metropolitan Board of Works have been intrusted with the extinction of fires. In the same period the population has only increased 28 per cent., and the ratable annual value of property 88 per cent. And in 1882, according to such of the accounts as I have been able to see, the losses bore a higher proportion of the premium receipts than in the year before, notwithstanding that the Fire Brigade has been strengthened from year to year at an increased annual expenditure, in the period 1866 to 1882, of about 160 per cent.

It will be understood, however, that no increase in the force and equipment of the brigade, within reasonable limits, can by any possibility give the same security as an efficient system of fire hydrants, and more than one select committee has reported in favor of putting down hydrants as soon as possible.

It has been stated by Mr. Bateman that the proportion of the property at risk damaged by fire or water in Manchester under the system of high-pressure hydrants, up to and including the year 1878, has been reduced to one-seventh of what it was before the introduction of the hydrant system.

If hydrants can be made to do for London only one-half of what they have done for Manchester, they will save the community something like a million sterling annually, to say nothing of the higher question of the saving of life.

The whole supply of water is obtained and delivered by pumping conducted by eight commercial companies under no obligation to provide pressure or even water sufficient for the extinction of fires. Such water as there may happen to be available for the purpose they are obliged to supply gratuitously. The supply for fires, as regards quantity, is generally sufficient. According to Captain Shaw's reports during the last three years, there were only 17 cases of short supply out of the 5788 fires attended by the Fire Brigade, or little more than ¼ per cent., while the average during the last twelve years has been under ½ per cent. Constant supply is being gradually introduced, and already considerably more than one half of the total length of streets (including the most important thoroughfares) contain constantly charged mains. It may therefore be broadly stated that as regards quantity the whole, and as regards constant supply considerably more than half of the metropolis, including all the most important streets, is in a position to be fitted with hydrants.

Throughout the City hydrants have been attached directly or by branches to the constantly charged mains, and if the pressure in that one square mile of the 121 within the metropolitan area were such as to admit of fire engines being dispensed with in all cases, nothing more would remain to be desired there in respect of the water supply for fire purposes. The same observation applies to some other parts of the metropolis where constant supply has been introduced, and were a few hydrants have been put down.

But it is in the matter of pressure that the water supply is deficient. The water is there in abundance, but it cannot be brought to bear upon a fire without the intervention of fire engines, and until it can the protection against fire cannot be considered to be adequate. A large number of observations were taken by the Metropolitan Board of Works in 1875 over their whole area, and it was found that the pressure varied considerably; about 10 per cent. of the observations showed a pressure of over 50 lb.; all the rest were lower, and the averages throughout the metropolis were about 30 lb. in the daytime without any exceptional draught upon the pipes such as that required for a fire.

The Fire Brigade Committee took much evidence in 1876 upon the question of the maximum requirement for a fire. Captain Shaw put it at 2000 gallons per minute in fourteen jets of about 150 gallons each, through an aggregate of half a mile of hose, or 200 ft. of hose for each jet.

The experiments made at Grays in 1876 by Sir Joseph Bazalgette, Sir. Frederick Bramwell, and Mr. Edward Easton establish the fact that to force 150 gallons per minute through the ordinary 2½ in. Fire Brigade hose a head of 3 in. is required for every foot of hose, or 50 ft. of head for 200 ft. length of hose. If the 150 gallons are discharged through an inch nozzle, the jet will ascend to a height of from 75 ft. to 84 ft., and the pressure at the back of the nozzle requisite to obtain this discharge is 98 ft. head. Adding to this the hose friction, equivalent, as above stated, to 50 ft., the total pressure required at the hydrant or engine will be 148 ft., or in round numbers, 150 ft. head, equivalent to 65 lb. per square inch. It follows therefore that the average pressure, about 30 lb., throughout the metropolis is less than one half the pressure required for a good jet from a hydrant. Such then are the physical conditions of the metropolitan water supply in relation to fires, viz., a copious supply with a low pressure, requiring the intervention of fire engines.

* Abstract of paper read before the British Association at Southport.

Proposals have been made from time to time for overcoming this difficulty as to pressure, and for improving in other respects the water supply required for fire extinction. These have included schemes for (*a*) altering the whole system to give a constant high pressure service; (*b*) for providing separate fire mains; and also (*c*) for laying down independent mains carrying water intended exclusively for culinary and fire purposes, reserving the present water for washing and the like.

In any water supply for fire purposes it is certainly desirable that the pressure should be moderately uniform in the hose, whatever may be the level of the locality. This uniformity of pressure is practically obtained by the use of fire engines as at present. But where efficiency depends upon the power being available on the instant that the occasion for its use is discovered, the mode of supplying it by fire engines is eminently unsuitable. And when it is considered what enormous distances have to be traversed by the engines uselessly, and the conditions under which the journeys are made, it will be found that it is not only unsuitable but also not economical. Last year, Captain Shaw reports, the engines made 29,000 journeys, and ran more than 66,000 miles, or an average of 34½ miles for each of the 1926 fires that occurred. According to the evidence given before the Fire Brigade Committee, it is only at about 20 per cent. of fires that the engines are actually used for pumping, and therefore for every time fire engines are used to pump water upon a fire there is run by them a distance of 172 miles.

In the last ten years the distance run by the engines annually has increased nearly 300 per cent.—a sure indication, if one were needed, of the vigilance and energy of the Fire Brigade, but equally a strong reason for strengthening their hands by the substitution of some other mode of supplying the power exactly when and where it is wanted.

It is now more than thirty years since Sir William Armstrong first introduced his well-known accumulator system of hydraulic power. There is hardly an important dock or goods terminus anywhere that does not employ it, and it is recognized after long experience as being the best and cheapest mode of applying power in many other situations. Hydraulic power was put down some years ago in Hull, and a company is at the present time, under authority from Parliament, introducing it in certain districts within the metropolis on both sides of the river. There can be little doubt but that its extension in this direction is destined to be very wide when its advantages come to be more generally known.

By the use of the injector hydrant, which has already been largely introduced by Sir William Armstrong and Co., the hydraulic power system has been found to be especially applicable to the production of jets of water for fire extinction in cases where the ordinary supply has not sufficient pressure for the purpose.

My proposition is to apply to the metropolis generally this system of hydraulic power and hydrants. To put down under the footways, wherever the existing water supply has sufficient pressure, small pipes for the conveyance of the high pressure or power water having a pressure of from 800 lb. to 1,000 lb. per square inch, from the pumping engine and accumulators to the hydrants. The pumping would be done by steam, gas, or electro-motive engines controlled by accumulators, placed at or near the existing Fire Brigade stations, or, if room could not be found there, at some of the police stations. The water both for working the engines and for supplying the high pressure pipes would be derived from the existing constantly charged mains, and if applied wholly for fire purposes would be furnished free of expense.

The injector hydrant depends for its action upon the principle of the "lateral inductive action of fluids," a principle long well known and utilized in various ways, as, for instance, by millwrights to draw off the back water in floods, in the jet pump, in Giffard's injector, and in the blast pipe.*

In a double hydrant there is a branch for applying water at the ordinary moderate pressure; the branch may be short, or it may be long enough to reach the main under the road to the hydrant placed under the footway. An ordinary screw-down valve closes this branch. A branch from a small hydraulic power pipe, bending upward, terminates in a nozzle directed into the ascending limb of the hydrant; and beyond this nozzle are two trumpet shaped guide tubes held in an iron casing.

The quantity of power water necessary to produce any required jet depends upon the pressures of the low pressure supply. A table is appended giving the quantity of power water required for various pressures of supply in order to produce an inch jet of 150 gallons a minute. As an illustration, with a low pressure supply of 30 lb. the quantity of power water would be 25 gallons for each 150 gallon inch jet, and for fourteen such jets it would be 353 gallons per minute. Fourteen jets on a single line of pipe could hardly be required at one time, but assuming that they were and that the point were distant half a mile from each of only two stations, this quantity of water could be sent through a 3½ in. pipe with a loss of only 12 per cent. of the power; and without greater loss an engine six miles away from a fire could send through a pipe of the same small size power sufficient for a jet of 150 gallons per minute, taking the ordinary supply to have no pressure whatever. The actual size of the pipes would of course be determined by the extent of the district assigned to each engine; the smaller the district the smaller the pipes, but on the other hand the greater the number of engines.

It will be observed that in this system whatever pressure the ordinary supply may have is fully utilized, while, as is well known, the fire engines do not avail themselves of it, but the water from the pipes is discharged into cisterns and pumped from the pavement level. With an average pressure of 25 lb. in the mains while discharging, the efficiency of the hydrants would be at least double that of the fire engines.

Pipes of these small diameters could be readily laid at a small fraction of the cost and inconvenience of putting

* An engraving of a double injector hydrant fitted to an 8 in. main will be found at page 80, vol. xxviii., of *Engineering*.

down the mains and pipes required to bring the water in large volumes from distant reservoirs, and to distribute it without serious diminution of head, which in order to supply even a third of the metropolitan area would involve, as we have seen, according to the late Mr. Easton, mains of 33 in. in diameter and more. The cost of erecting the pumping engines and accumulators would constitute only a relatively small proportion of the principal outlay, which would be made up chiefly of the cost of the pipes and hydrants. The latter, however, would not be much more expensive than the ordinary hydrants, the cost of the branches from the mains or service pipes, the disturbing and making good of pavements and roads, and the greater part of the hydrant itself being common to both.

I estimate on reliable data that the whole of the metropolis could be protected by an efficient system of hydrants in this way for the sum of 1,500,000*l.*, including pipes, hydrants, engines, pumps, accumulators, etc., and that the working expenses at the outside would not exceed 3,000*l.* per annum.

With interest, as in the other proposals, at 3½ per cent., the annual cost involved will not exceed 55,500*l.*

By the introduction of an efficient hydrant system Sir Joseph Bazalgette, Sir F. Bramwell, and Mr. Edward Easton were of opinion that there would be a saving of present and contemplated expenditure upon the Fire Brigade of 60,000*l.* per annum, and comparing the metropolitan expenditure with that of Liverpool and Manchester and other places having efficient hydrant systems, it would appear that the saving would be even more considerable.

It may therefore be taken as certain that the introduction of this system would involve no greater, if not a less, tax upon the metropolis than it bears at present, even neglecting altogether the profit which would be derived from the supply of hydraulic power for commercial purposes.

Reverting again to the experience of Liverpool, Manchester, etc., it may also be taken as proved that the introduction of the proposed system would prevent the rapid growth of the expenditure for fire extinction.

The system could be introduced at once, either generally or locally, without waiting for the consolidation or purchase of the water companies, and no existing rights or interests would be interfered with.

The pressure of the water in the existing mains and service pipes would not be increased, and consequently no risk either to them or to the house fittings would be incurred; and the necessity which otherwise would exist without altering these would be avoided.

Exceptionally high jets could be obtained wherever they might be required for the protection of the highest buildings, whether public or private, irrespective of the contours of the ground, and London would at once be spared the enormous destruction of property now occurring above and beyond that which would take place under efficient hydrant protection, probably exceeding in value, as we have seen, the sum of one million sterling last year.

With its aggregation of untold wealth of life and property depending for protection from fire upon a mere handful of men, who cannot approach their work except at the risk of life and limb to themselves and to others, often losing many minutes in crowded, narrow, and tortuous streets, when each moment adds to the difficulty of the work before them, London is surely above all places where an efficient hydrant system should be brought to bear without loss of time to aid the brigade in its arduous work.

APPENDIX.

TABLE I.—*Quantity of High Pressure or Power Water required for various Heads of Low Pressure Supply to produce the Jet described below.*

Low Pressure Supply. Lb. per sq. in.	Ft. head.	High Pressure, at 700 lb. per sq. in. Gals. per min.
60	138	3·7
50	115	10·9
40	92	18·1
30	69	25·2
20	46	32·10
10	23	39·6

This table is founded on the results of experiments with from 10 lb. to 20 lb. per square inch pressure of low pressure supply. The high pressure is taken at 700 lb. per square inch. The quantity is given for a jet of 150 gallons delivered through a 1 in. nozzle, variously estimated to ascend to a height of from 75 ft. to 84 ft., and requiring a pressure of 100 ft. head at the back of the nozzle. The length of the hose is taken at 200 ft. of 2½ in. brigade hose, the resistance of which for that discharge is taken at 3 in. head per foot of hose.

TABLE II.—*Metropolitan Water Supply. Length of Streets containing Constantly Charged Mains within the Metropolis.*

From Colonel Bolton's Report for July, 1883.

	Miles.
Chelsea Water Works Company	68
Lambeth "	136¾
Grand Junction "	48¾
Southwark and Vauxhall Water Works Company, including services	119
East London Water Works Company	120
Kent "	85
West Middlesex " (about)	90
New River "	216
	883½

A STEAMER FOR THE CONGO.

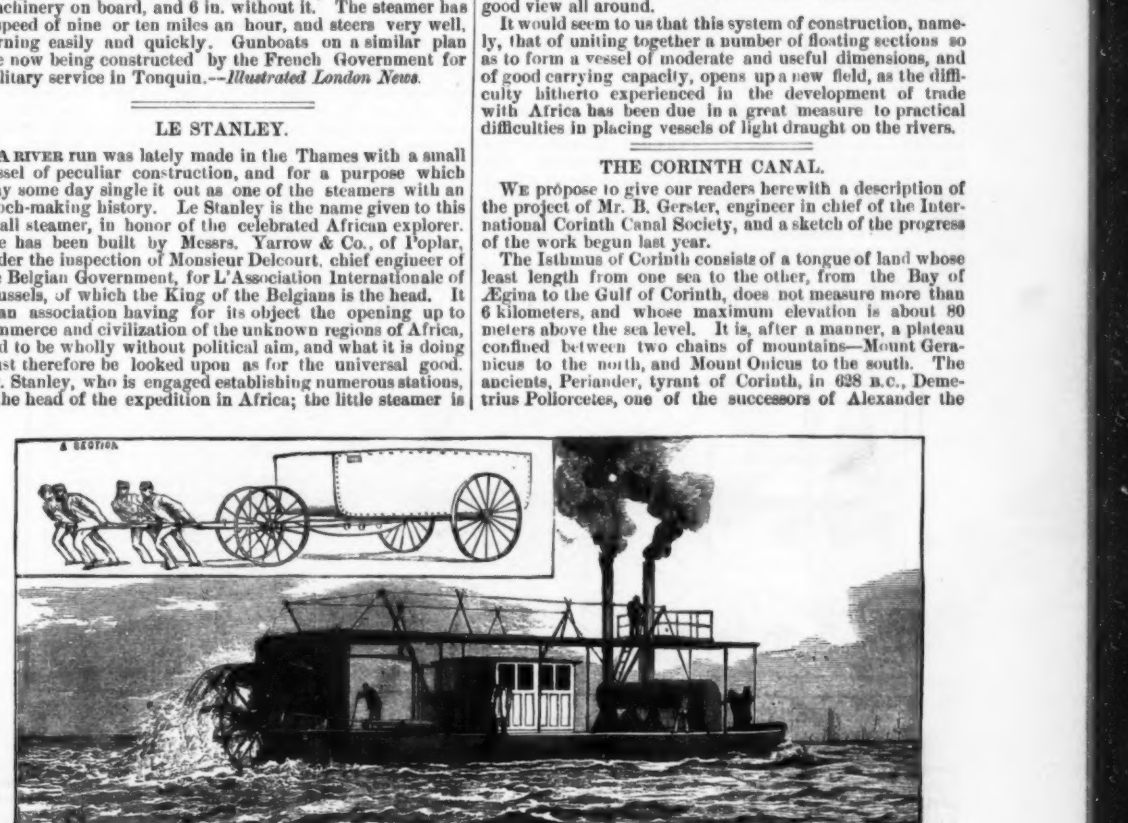
THE expedition sent out chiefly by the King of the Belgians, at his private expense, for the exploration of the river Congo and for the opening of a route of commercial traffic in West Central Africa, with the personal assistance of Mr. H. M. Stanley, is now to be provided with a steamboat of very novel design, which has been constructed by Messrs. Yarrow of Poplar, and which was successfully tried a few weeks ago on the Thames. This vessel, to be named "Le Stanley" in honor of the celebrated explorer of Central Africa, is composed of six oblong pontoons of galvanized steel, 18 ft. long by 8 ft. 6 in wide and 4 ft. deep. These pontoons, which form sections of the vessel and each of which is watertight and can float by itself, are placed side by side and fastened together, and to them is added a bow-piece and a stern-piece. The whole forms a hull 70 ft. long by 18 ft. beam. The sections are so bolted together that they can be readily disunited and as readily put together again. On the bow division are placed two steam-boilers of the locomotive type, capable of working up to 150 lb. per square inch. The boilers have capacious fire-grates for burning wood, which will be the only fuel procurable. On the stern division are the engines, which are designed for a working pressure of 140 lb. per square inch. There are two cylinders, one on each side of the vessel, each 10½ in. diameter and 2 ft. 6 in. stroke. The piston-rod of each cylinder is connected with a crank shaft, carrying a stern paddle-wheel 10 ft. diameter and 12 ft. breast, and placed well aft of the vessel. The strain on the boat from these weights, being placed at either end, is taken by a system of light steel tie-rods, by means of which the whole of the vessel is well braced. The ship is fitted with a pair of balanced rudders, and is steered from a bridge placed well forward, and about 12 ft. above the water, giving the steersman a good view all round. Above the main deck, and completely covering it, will be a wooden awning deck, which in an African climate will be necessary to protect the passengers and crew from the sun. On the main deck is a small, well ventilated saloon. It is intended to ship this steamer in sections direct to the mouth of the Congo, where she will be put together afloat. She will then steam up the river as far as it is navigable, and when further navigation becomes impossible, she will be taken to pieces for transport overland. Each section will then be placed on four light wheels, of steel, having very wide tires, forming a wagon to convey the machinery and the stores. The draught of water, when unloaded, is only 14 in., with the machinery on board, and 6 in. without it. The steamer has a speed of nine or ten miles an hour, and steers very well, turning easily and quickly. Gunboats on a similar plan are now being constructed by the French Government for military service in Tonquin.—*Illustrated London News.*

LE STANLEY.

A RIVER run was lately made in the Thames with a small vessel of peculiar construction, and for a purpose which may some day single it out as one of the steamers with an epoch-making history. Le Stanley is the name given to this small steamer, in honor of the celebrated African explorer. She has been built by Messrs. Yarrow & Co., of Poplar, under the inspection of Monsieur Delcourt, chief engineer of the Belgian Government, for L'Association Internationale of Brussels, of which the King of the Belgians is the head. It is an association having for its object the opening up to commerce and civilization of the unknown regions of Africa, said to be wholly without political aim, and what it is doing must therefore be looked upon as for the universal good. Mr. Stanley, who is engaged establishing numerous stations, is the head of the expedition in Africa; the little steamer is proceeded with. To each section while still afloat will be secured four large light steel wheels having very wide tires. This being done, the divisions are ready to be hauled out of the water and over land, and what was once a section of a boat now becomes the body of a wagon of ample capacity to convey the lighter portions of machinery and stores. On arrival at the next navigable part of the river, these wagons so constructed are run into the water, the wheels are removed and the various divisions reunited, forming again an entire vessel. In this way the journey can be continued, the steamer being taken to pieces and put together as often as circumstances require.

At the preliminary trial on Saturday the vessel went through numerous maneuvers; the mean draught was 14 in. in working trim, and with a steam pressure of 100 lb. per square inch a speed of nine and a half to ten miles an hour was obtained—an excellent result, taking into consideration the proportion of length to beam and other peculiarities of the craft. Great steering power is of course necessary, and the most striking performance was the marvelous facility with which the boat could pivot on a center only a little within a point a few feet from the stern, which was very remarkable, and clearly rendered this type of steamer admirably suited for tortuous and winding rivers. On the deck is a small, well ventilated saloon, and the steering wheel is placed high up on a bridge some 12 ft. above the water, giving the pilot a good view all around.

It would seem to us that this system of construction, namely, that of uniting together a number of floating sections so as to form a vessel of moderate and useful dimensions, and of good carrying capacity, opens up a new field, as the difficulty hitherto experienced in the development of trade with Africa has been due in a great measure to practical difficulties in placing vessels of light draught on the rivers.



LE STANLEY, A PORTABLE STEAMER FOR THE CONGO.

to assist him in his operations, especially in the district of the Congo and its tributaries; and some idea of the magnitude of an expedition of this kind may be formed when it is stated that no less than 500 natives have already been engaged to accompany the steamer and assist in its transport overland. About the middle of last year the Belgian authorities placed themselves in communication with Messrs. Yarrow & Co., with a view to build a thoroughly serviceable steamer of exceptionally shallow draught and able to steam in places where there is not water sufficient for vessels constructed in the usual way. The main point, however, was to design something that could be easily transported overland, so as to pass by and avoid the numerous rapids and cataracts which render navigation impossible. With these requirements before them, Messrs. Yarrow & Co. have constructed the present steamer; it consists of six galvanized steel square-shaped pontoons, 18 ft. long by 8½ ft. wide by 4 ft. deep; these sections, each of which is watertight and therefore floatable, are placed side by side; to these are added a bow-piece and a stern-piece, making together a hull 70 ft. long by 18 ft. beam. By means which we shall describe at more length at another time these sections can be readily united and disunited, and this can be done afloat. On the bow division are placed two boilers, and on the stern division the engines, which are designed for a working pressure of 140 lb. per square inch, and have cylinders 10½ in. in diameter by 2½ ft. stroke, which, by means of a crank on each side, drive a paddle-wheel situated aft well clear of the stern. The engines are each made up on a steel tube as a frame. The strain due to these weights being concentrated at the extreme ends of the boat is taken by a system of light steel tie-rods above, secured to tubular king posts; the effect of this system is at all times to throw a compression on the hull, thereby tending to keep the various sections together in close contact and free from alternating strains. Above the vessel, and completely covering it, is a wooden awning deck, which in an African climate is very necessary to protect the passengers and crew from the sun. The boilers are made with very capacious grates, and of course wood is the only fuel procurable, and will not always be the driest and best adapted for making steam.

It is intended to ship this steamer, in her several sections, direct to the mouth of the Congo, where she will be put together afloat, which, it is contemplated, will not occupy more than twenty-four hours. She will at once proceed, under her own steam, as far up the river as it is navigable; then be taken to pieces for transport overland; and in this operation will be seen one great novelty in her design. After the machinery is removed from the deck the hull will only draw 6 in.; it then is brought into exceedingly shallow water, and the operation of disconnecting the various sections

THE CORINTH CANAL.

WE propose to give our readers herewith a description of the project of Mr. B. Gerster, engineer in chief of the International Corinth Canal Society, and a sketch of the progress of the work begun last year.

The Isthmus of Corinth consists of a tongue of land whose least length from one sea to the other, from the Bay of Ægina to the Gulf of Corinth, does not measure more than 6 kilometers, and whose maximum elevation is about 80 meters above the sea level. It is, after a manner, a plateau confined between two chains of mountains—Mount Geranicus to the north, and Mount Onicus to the south. The ancients, Periander, tyrant of Corinth, in 628 B.C., Demetrius Poliorcetes, one of the successors of Alexander the Great, Julius Cæsar, and then Caligula, who had not failed to see all the interest and importance of the Corinth Canal, from the standpoints of commerce and navigation, had only thought of doing what Nero actually undertook to do, and the works of exploration of the latter are, after a lapse of eighteen centuries, perfectly recognizable and show the measure of the human force that this emperor had at his disposal. On the Kalamaki side (Gulf of Ægina) we perceive a large trench 70 meters wide at its highest part, and 40 at its lowest, by about 200 in length. The earth is banked up at the two sides of the trench, and the latter ends abruptly in a nearly vertical front. On the Corinth side, although the natural ground offers less depression, vestiges of Nero's works are none the less visible. We find throughout the entire breadth of the Isthmus a succession of pits 2 meters square, these being soundings which had been made to a depth of 20 meters, and one of which has served for ascertaining the character of the ground upon which to locate the abutments of the metallic bridge that is to be thrown over the canal on the route from Athens to Corinth.

The lines studied by Mr. B. Gerster, with a view of determining the best route, both from the standpoints of economy in cubage, and convenience of navigation, are three in number.

The first reproduces the project of Nero, whose pits, extending in a straight line throughout the breadth of the Isthmus, permit of following the easily recognizable route. Its total length is about 6,400 meters, including the lengths of the ports to be dredged for establishing a channel of the regulation depth of 8 meters. The total amount of material to be removed, calculated from profiles of variable slopes, according to the nature of the ground found by numerous soundings, reaches about 10,000,000 cubic meters. Besides this, Mr. Gerster studied two other routes, one of which possessed the advantage that it presented a slightly less cubage to be excavated, with a maximum altitude of 75 meters. Per contra, this line had the inconvenience of presenting numerous curves of 2,000 meters radius—a drawback which is not sufficiently offset by the economy in cubage, which latter may be estimated at about 6,000,000 cubic meters. The second line starts from New Corinth and ends at the Bay of Kechrias at about 2 kilometers from the present mouth of the canal, and would have given a canal 11 kilometers in length, with more than 12,000,000 cubic meters of material to be removed.

The International Corinth Canal Society was led, then, to adopt the ancient line of Nero as presenting the most economical conditions of construction, and the most advantageous ones for navigation in consequence of its being shorter and straighter.

As shown by the annexed longitudinal profile (Fig. 1), the canal consists of one vast trench 87 meters in height at its highest point, putting the Bay of Ægina in communication with the Gulf of Corinth. Its section will be exactly the same as that of the Suez Canal, 22 meters in width at the bottom, and 8 meters in depth at lowest tides. The banks of the cuttings will have a slope of one-tenth in the rocky parts, of 2 to 1 in the sandy ones, and of 1 to 1 in the parts where the earth is a little firmer, thus giving the water surface a minimum width of 23·6 meters, and, as far as can be judged at present from the ground gone over, a maximum one of 45 meters.

Two routes cross the canal. One of these, running from Corinth to Athens, passes at an elevation of 60 meters, and

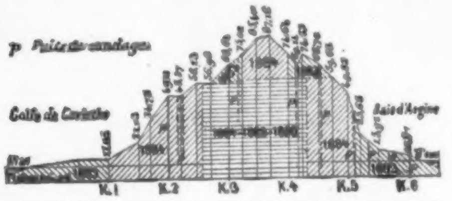


FIG. 1.—LONGITUDINAL PROFILE OF THE CANAL, SHOWING THE ANTICIPATED PROGRESS IN THE WORK.

will necessitate no other work than the erection of a metallic bridge, the position of whose abutments is now being determined by soundings in one of Nero's pits in the vicinity that has already been excavated to a depth of 40 meters. The other, running from Corinth to Lutraki, a small village that possesses a thermal spring at the foot of Mount Geraniens, passes along the edge of the sea, and will require a bridge and a deviation to carry it to a sufficient height to give free passage to the masts of ships. Finally, the railroad from Piræus to the Peloponnesus, now in course of construction, will cross the canal by a metallic bridge that the engineers have not as yet determined the position of. (Fig. 2).

Mr. Gerster, before adopting a system of excavating a trench so exceptionally large, made a dozen soundings to different depths, varying from 1 to 2 meters, in the alluvial portions in the vicinity of the two gulfs to be united, and to a depth of 35 and 40 meters in the rocky parts at the summit of the cutting. He was thus enabled to determine with care the geological profile of the Isthmus. This profile indicates the existence of a central mass of compact white chalk, covered on the two sides with compact yellow sand, and with an upper stratum formed of marly sand in which are interposed thin layers of foliated conglomerate of exceptional hardness. The approaches to the canal consist of alluvial sand on the Corinth side at the west mouth of the canal, and of clayey sand on the Kalamaki side, at the other mouth.

The excavating project now in course of execution, devised by Mr. Gerster, consists in the removal of the upper stratum of the trench, that is to say, of all that lies above an altitude of 47 meters, by the method of shafts and adits, in which the excavated material will be removed by means of large cars of 3 cubic meters capacity drawn by locomotives and emptied into the very favorably situated valleys in the vicinity. This cutting, an element of the total excavation, cubes about 1,800,000 meters, and will be attacked at its two extremities at once, thus permitting of the removal of 900,000 cubic meters at each end. This work is now under full headway, and is so regulated as to permit of the complete removal of the upper stratum within the space of two years.

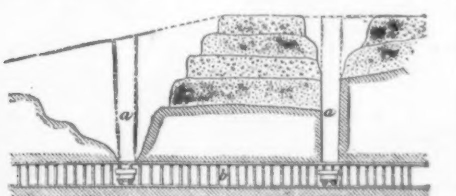


FIG. 3.—WIDENING THE MOUTHS OF THE SHAFTS.

While this work is proceeding, operations will be begun in the alluvions at the two extremities of the canal at once, by means of dredging machines of middling size, and of sand pumps that will empty the material either on the banks of the canal or into punts that will be towed out to sea and emptied therein. The dredging machines will dig out the channel to its full width in measure as the excavation advances, and will reach the great mass of chalk at the end of the second year, when the entire capping will have been removed by the method already mentioned.

It will then remain to remove, during the third, fourth, and fifth years, that great rocky mass that represents a cubage of 5,000,000 meters, by powerful means which will permit of a minimum advance of 2 meters per day being made on each side of it, or a total of 4 meters. These powerful means we shall see applied next year at the epoch fixed for the finishing of two large dredging machines of an exceptional power, which will be capable of loading in punts 500 cubic meters of material per hour. These have been studied with care, and are now in course of construction at the works of Messrs. Demange and Satre at Lyons. They are to cost 600,000 francs each, and are to be delivered at the canal on the 1st of January, 1884.

Let us now return with more detail to each of the operations mentioned above.

The upper stratum forms a mass, as we have said, of 1,800,000 cubic meters, which is to be removed within a period that has been fixed at two years. The lowest points of this excavation, at an altitude of 47 meters above the sea, are the two points of attack at each extremity. The highest point, at an altitude of 79 meters, is, at the same time, the most elevated point of the plateau to be pierced. The method of shafts and adits as applied on the Corinth Canal consists in excavating at the base of the cutting a gallery (supported by timbers) of sufficient section to allow of the passage of cars only (the locomotive never entering), and the profile of which presents a gradient of 5 mm. per meter, permitting of the moving of the full cars, while at the same time rendering the starting of the empty ones easy. At a certain distance from the head of the adit there is excavated from the top of the latter to the exterior a vertical shaft having a section of about two square meters, and which thus forms an annular space through which will be thrown the material derived from the widening of the upper part of the shaft, and which will be received in the cars running through the adit below. (Fig. 3.) There is thus excavated a sort of a funnel, and the material filling the cars will be removed by a locomotive to the place of deposit. Care has been taken to provide the lower extremity of the shaft with a row of strong timbers running across it in different directions so as to break the fall of large blocks that might crush the cars. These timbers form a kind of grating whose bars may be moved to one side by a man provided with a crow-bar, when a large block chances to get lodged therein.

During this work a special gang of men has begun the excavation from below of a second shaft like the first, and at such a distance from it that, at the surface of the earth, the two circles that form the base of the reversed cone shall be tangent, provided that the ground has taken its natural slope corresponding to the earth traversed. This second shaft having been finished, its upper part is cut away by steps, the rubbish being allowed to fall into the cars in the adit below. The widening of this second shaft proceeds concurrently with that of the first, and then the excavation of a third one is begun, and the work proceeds as regularly on all the shafts together, although in different degrees of advancement. The locomotive returning from the dumping grounds, where the full train has just been unloaded, reaches the entrance of the adit and sends the empty cars into it, and each gang of laborers stops one of these under each shaft. One of the cars proceeds as far as the heading in order to carry thither the necessary supporting timbers and to bring back the excavated material. Two locomotives at each working point suffice to perform this service, one of them proceeding to the dump heap while the other distributes the empty cars in the adit.

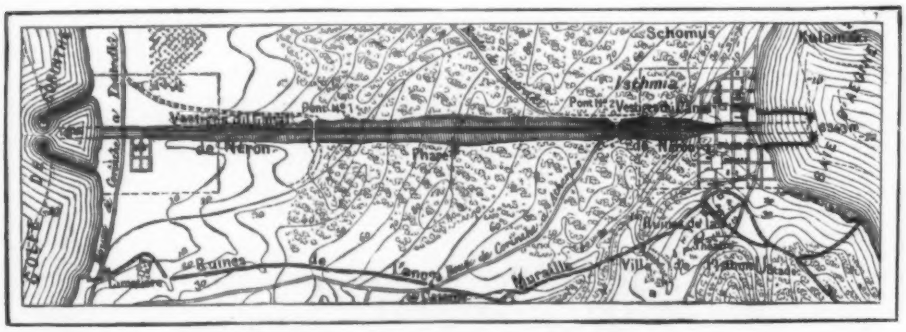


FIG. 2.—ROUTE OF THE CORINTH CANAL.

The regularity with which the work is performed permits of unloading a train of cars in 20 minutes, amounting to a total loading and unloading of 500 cars per day, or 1,500 cubic meters of excavation daily for each point of attack, or 3,000 cubic meters for the two. The removal of the 1,800,000 cubic meters of superficial material in 600 days, or two years, is thus insured of.

We have said that the two approaches to the great cutting would be excavated by ordinary means; two apparatus will be employed—the sand pump and the ordinary dredging machine.

The dredging machine constructed at Vienna is 30 meters in length, 6·3 meters in width, and has a draught of 1·5 meters. Its bucket-frame, which consists of a solid iron girder, is 18 meters in length. The buckets, which are 29 in number, have a capacity of 280 liters; the number of revolutions per minute of the engine is 67, and that of the nave of the wheel 10, thus representing a passage of 19 buckets per minute. The total weight of the machine is 75 tons, and it is capable of dredging and loading into punts 1,500 cubic meters per day.

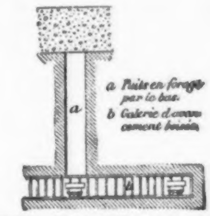


FIG. 4.—DETAILS OF SHAFTS AND ADITS.

The alluvions on the Corinth side, being formed of very fine non-argillaceous sand, it was thought that it would be advantageous to dredge them by means of a sand pump analogous to those employed at Port Saint Nazaire, and at Port Dunkerque—apparatus devised by Engineer Bazin, whose dredging machine, called the "Bazin Extractor," has been operated with success in England and America. Imagine a boat which contains in its bottom an aperture through which passes a flexible pipe whose other extremity terminates at a few centimeters from the sand or mud to be dredged. According to the principle of communicating vessels, a column of water of a certain height, which acts by pressure upon the aperture of the pipe, will cause the liquid to enter the latter until the water level is the same in the boat and at the exterior. The boat thus becomes filled with water, and, as may be seen, the ascending motion of the latter will carry with it a certain quantity of commingled mud and sand. This simple apparatus does not suffice, however, to suck up sand constantly and regularly from the bottom, and, reduced to this simple expression, will always require that the sand that has accumulated in the boat shall be taken up, by some means or other, to be emptied into the grounds reserved for the material. Mr. Bazin therefore conceived the idea of placing at the upper extremity of the suction pipe a centrifugal pump, which, on being set in motion, produces a depression that varies with the speed given it, and that becomes added to the weight of the water which is acting upon the lower extremity of the pipe, so as to disintegrate the sand and mud mixed with the water and cause it to ascend easily. This mud and sand traverses the pump in this way, and is thrown by a force pipe either into the pumps ready to receive it or directly, long chutes, on to the banks, of the canal. Such is the principle of the Bazin extractor.

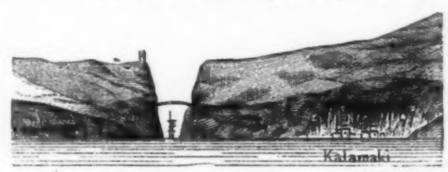


FIG. 5.—END VIEW OF THE CORINTH CANAL.

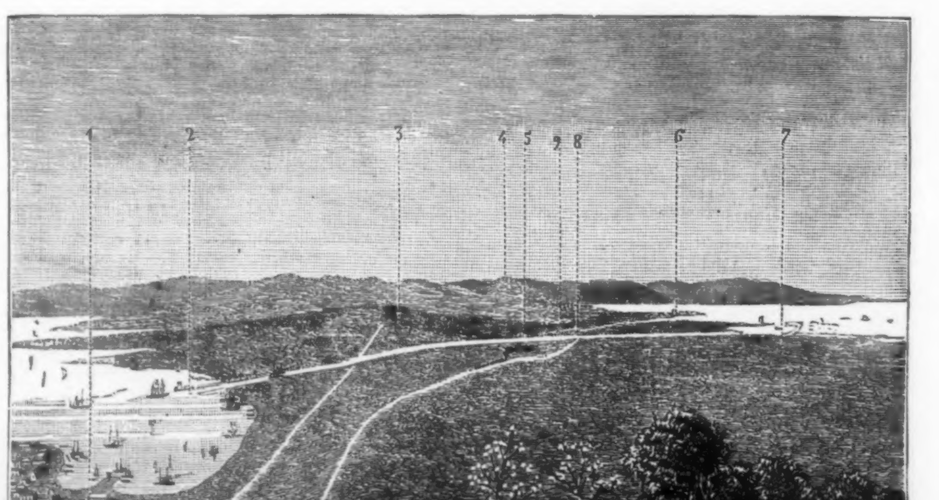


FIG. 6.—BIRD'S-EYE VIEW OF THE ISTHMUS OF CORINTH.

1. Gulf of Ægina and Kalamaki. 2. Outlet of the Canal into the Gulf of Ægina. 3. Ruins of the ancient city. 4. Acro-Corinth. 5. Lighthouse. 6. New Corinth. 7. Outlet of the Canal into the Gulf of Corinth. 8. Railroad Bridge. 9. Ruins of ancient Corinth.

The dredging apparatus employed at Corinth consists of a centrifugal pump mounted in the stern of an angle-iron boat 15 meters in length by 6 in width, which likewise contains the motor designed to give it a rapid rotary motion. The cast-iron pump, which is 0·80 m. in diameter, is provided internally with a steel band affixed to the cast iron so as to protect it against grippings due to sand and other materials that enter the pump. It is provided with four buckets, which are furnished with rubber bands so as to permit of obtaining a more perfect closing, and consequently a more perfect vacuum. The suction and force pipes have an internal diameter of 0·4 m. The former is provided at the extremity that plunges into water with a sort of rose having apertures 12 cm. in diameter, so as to absolutely prevent the entrance of too large stones. The priming of the pump, that is to say, the filling of the suction pipe, is effected by means of an injector—a sort of a simplified Giffard apparatus—which consists of a pipe into which enters a jet of steam debouching through a small orifice. As the pipe communicates with the suction, there is produced a draught of air, and the water rises in the suction pipe until it fills the pump. The motion given the pump varies between 360 and 400 revolutions per minute. The motor is of the compound type, was built by the Central Society of Pontin, is of 50 H.P., and revolves with a velocity of 90 to 100 revolutions per minute. The apparatus discharges 2,000 cubic meters of material per 10 hours' work. Mr. Gerster estimates that with the two sand-pumps, one at the Corinth works, and the other at those of Isthmia at the other end of the canal, it will be possible to take out about 2,000,000 cubic meters of material in three years of 250 days (or 750 days), the pumps working at the same time as the dredgers.

The removal of the great rock mass, although it does not present the enormous difficulties that arose during the piercing of the Saint Gothard, and that came near compromising the success of that grand work, presents nevertheless a great interest as regards the simultaneous use of the new mechanical means of drilling blast holes and the use of dynamite. The great progress made in recent years, the multiple experiments already tried with a considerable number of drills—percussion as well as rotary—the well known results that can be obtained with each of these machines, and, on another hand, our perfect knowledge of the effects of dynamite, will reduce the question to simple trials of all the conditions offered by the diverse nature of the grounds traversed—conclusive trials from whence will arise a judicious selection of such or such an apparatus in preference to all others. It is none the less certain that this work, which has not its counterpart in Europe, and which, in order to be well conducted under every condition of regularity and economy, will require a perfect knowledge of all the machines employed, will remain as an example of a rapid excavation of an enormous mass of rock, of 5,000,000 cubic meters, inclosed between two very high and close slopes that offer at their base, that is to say, at the bottom of the canal, scarcely enough surface to allow of the necessary movement to the dredging machines and their punts.

The process adopted by Mr. Gerster consists in the excavation of vertical trenches, the highest of which, running from an elevation of 8 meters above the sea to one of 50 meters (the base of the previously removed capping), will be 50 meters in height and 2 to 3 in depth. This excavation will be effected through the use of blast holes 7 to 10 centimeters in diameter, at a distance of 2 to 3 meters from the face of the last cutting made, and spaced 4 to 5 meters apart. For a trench 58 meters in height, for example, 8 holes will be drilled, and these will be charged with a series of dynamite cartridges spaced 5 meters apart in the direction of the holes length. The cartridges of the same vertical cutting, being put in communication with each other through an electric exploder, will go off simultaneously, and produce, if not the fall of the entire cutting, at least of a considerable quantity of material into the channel that has been dug out in proportion as the work advanced, and this debris will be immediately taken up by the large dredgers already mentioned as having been built by Messrs. Demange and Satre.

Each of these dredging machines is provided with a single central bucket-frame carrying a chain furnished with buckets each of which has a capacity of 700 liters. The bucket-frame is so arranged as to permit of dredging to a depth of 8·5 meters beneath the surface of the water. The buckets will empty the material into a Y-shaped chute that will permit of its being directed at will into one or the other of the punts placed on each side and astern of the dredger, or into two punts at once. The vertical compound motor possesses sufficient power to cause 14 buckets per minute, filled with dredgings taken from a depth of 8·5 meters and weighing 1800 kilogrammes, to pass over the upper chain wheel, and is capable of giving an indicated power of 300 horses at a normal speed of 60 revolutions per minute under an initial pressure of 5 kilos. This engine likewise actuates a helix 2 meters in diameter in the stern of the dredging machine, and gives it a velocity of 120 revolutions per minute. The length of the hull is 40 meters and its breadth of beam 8·4. The apparatus for raising the bucket frame is an independent steam windlass. The motion of the bucket chain at the front is effected by two independent windlasses situated in the stern of the boat, and that of the chain astern by an independent steam engine which likewise actuates the two windlasses forward. Each of these dredging machines is capable of taking out 500 cubic meters of material per hour.

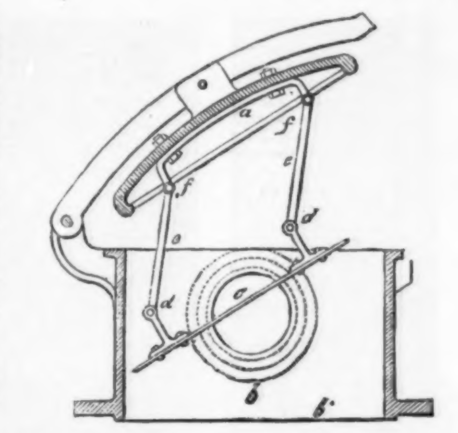
In sum, the work to be pursued is as follows: The removal of the 1,800,000 cubic meters of capping by the method of shafts and adits during the years 1883-1884; the excavation of approaches by ordinary dredgers and sand pumps (3,000,000 cubic meters) during 1883 and 1884; and the removal of the central mass (5,000,000 cubic meters) during the years 1884, 1885, and 1886. Total amount to be removed, 9,800,000 cubic meters.

The general execution of the work has been confided to the Societe des Ponts et Travaux en Fer (formerly the house of Joret & Co.), which has associated with itself the Association des Constructeurs. These two companies have taken the execution of the entire work in hand jointly and under bonds for the sum of 24,600,000 francs, thus preventing any contingencies in the expense of construction. The operations comprise the excavation of the canal and the building of jetties and such accessory constructions as bridges, guard houses, lighthouses, etc.

The general quarters of the enterprise have been installed at the eastern mouth of the canal, on the banks of the Bay of Ægina. What last year was only a vast desolated spot, offering to one's eyes only nude rocks—the characteristic aspect of Greece—is to-day a small colony of 2,000 inhabitants, consisting of engineers, office employes, and workmen, the embryo of a future commercial city favorably situated on the banks of the canal, and serving, so to speak, as a bond of union between the ports of the Mediterranean and those of the Black Sea.—*E. Pitsch, in La Nature.*

APPARATUS FOR PREVENTING OBSTRUCTIONS IN RETORT PIPES.

MR. NIERMEYER, director of the Deventer (Holland) Gas Works, has devised the apparatus represented herewith for preventing obstructions in the upright pipes during the operations of gas retorts. The vapors of tar which occur during the distillation of coal deposit in part on the inside surface of these pipes, and, combining with the coal dust carried along mechanically by the gas, form a viscid or even a solid mass which finally fills the interior of the pipe. To prevent this trouble, Mr. Niermeyer adapts (as shown in the cut) to the cover, *a*, of the orifice, *b*, a movable disk, *c*, that has nearly the same section as the head of the retort. This disk, *c*, is provided with two joints, *d*, that are connected by rods, *e*, with the joints, *f*, of the cover, *a*; when the retort is closed, the disk, *c*, reaches *b'*, and almost completely closes the lower part of the head, *b*, of the retort, and allows only a narrow annular interval for the gas to pass through. The vapors of tar being cooled by the disk, de-



posit upon the latter, which also retains at the same time the coal dust that is carried along mechanically; under these circumstances obstructions in the upright pipes become impossible.—*Chronique Industrielle.*

DOUBLE-ACTING CIRCULAR SHEARS FOR CUTTING PAPER AND CARDBOARD.

THE cutting of paper and cardboard designed for the manufacture of visiting cards, playing cards, etc., with the machines at present in use, consists of two distinct operations, viz.: a lengthwise cut, which separates the sheet of cardboard into strips, and a transverse one, which divides the strips into rectangular pieces.

The new machine shown in the cut is the invention of Messrs. A. & G. Lhermite, and is designed to unite these two operations into one, and to cut sheets of cardboard and paper into pieces of any shape.

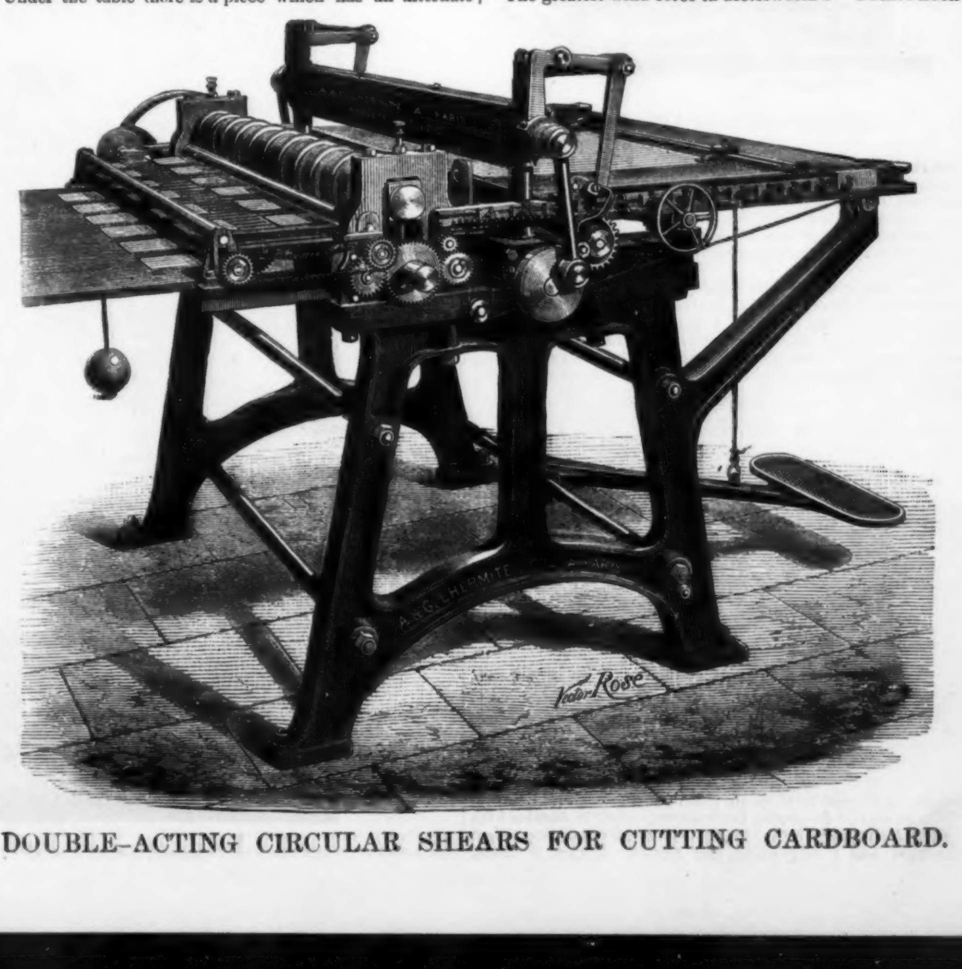
The machine consists of a feed table, upon which moves a bar provided with clips for seizing the sheet to be cut. This bar, which moves parallel with the straight blade, is actuated by counterpoises, and moves forward every time that a click, which is connected by bars with the blade-carrier, rises, and then at once falls upon certain movable pieces that are affixed to a lateral rack. This latter is connected with the bar, and the movable pieces that it carries serves as gauges, and may be moved according to the size to be cut.

The straight knife has a vertical motion, which is communicated to it by connecting rods fixed at the extremities of the blade-carrier at one end and to crank-plates at the other.

Under the table there is a piece which has an alternate backward and forward motion, and which leads the strips that have been cut by the straight knife under circular knives, of which the distance apart is regulated by means of rings. In order that these strips may not become disarranged, either by the cut or by falling upon the feed table, they are seized, before being cut, by a clip that automatically rises and falls, and only opens at the precise moment that the sliding bar is beginning its action.

The cards, after being cut, are carried along by an endless belt mounted upon two rollers, which have a continuous rotary motion and which are connected with each other by a pitch chain.

With this machine 300,000 visiting cards per day may be cut.—*Annales Industrielles.*



DOUBLE-ACTING CIRCULAR SHEARS FOR CUTTING CARDBOARD.

WIND FORCE.

I SEND herewith a measured sketch of the "Shah" memorial in Victoria Park, Portsmouth, England, a portion of which was blown down in the gale prevailing there on

Nov. 17, 1883. I also send a contribution to the methods for finding the wind force on that occasion.

The cubical contents of the block I find as follows:

	Cubic inches.
$9{\cdot}75^2 + 15{\cdot}5^2 \times 33$ (⅓ height)........ =	16,052·43
Small pyramid on top, $9{\cdot}75^2 \times 1{\cdot}83$.... =	173·96
	16,226·39
	= 9·39 cubic ft.

Taking Italian marble at 170 lb. per foot, this gives the weight of the block to be 14¼ cwt., or 1,596 lb. Let 1,596 lb. be acting with a leverage of 7·75 in., we get 12,369 inch-pounds.

The center of pressure, according to the method given in Spon's "Dictionary of Engineering," is 34 in. above base, and the area of one face is 7 ft. 6 in.

Let W = wind force, obtained as follows:

$$\frac{1596 \times 7{\cdot}75}{34 \times 7{\cdot}5} = 40{\cdot}8 \text{ lb. per ft.}$$

The velocity of the wind to produce this force is obtained in miles per hour as follows:

$$V = \sqrt{\frac{40{\cdot}8}{0{\cdot}00492}} = 91{\cdot}06 \text{ miles.}$$

The greatest wind force in Molesworth's "Pocket Book"

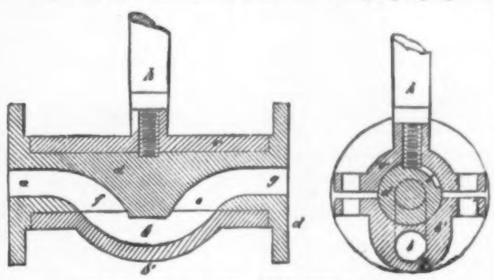
is given as 100 miles per hour, having a force per sq. foot of 49·2 pounds, and is described as a hurricane.

One remarkable feature of this wind at Portsmouth was pointed out to me by the keeper of the park, namely, the very confined space over which its action was visible. It broke one pole of a row supporting young trees, took off the roof of the bandstand (showing the great care that should be exercised in designing open structures of this kind in providing sufficient holding-down bolts), upset the "Shah" memorial, and that was all. This damage was done in a rectangle of, I suppose, about 150 yards by 50.—*John Sutcliffe, Building News.*

SAILLER'S WATER AND STEAM COCK.

MR. E. SAILLER, of Thann (Alsace), has recently taken out a patent for a cock of great simplicity, and one which is easy of regulation in case of wear, and which is perfectly tight.

It consists, as shown in section in accompanying figures,



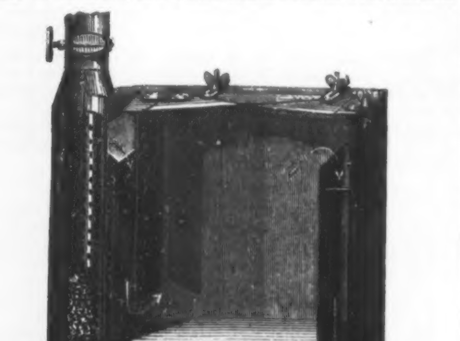
SAILLER'S WATER AND STEAM COCK.

of a cylindrical core, *d*, provided with flanges at its extremities that serve to couple it with a steam or water pipe. This core contains two channels, *a f* and *e g*, and in the external part of it there is a groove, *j*. The core, *d*, is held between two polished shells, *c'* and *b'*, which have the form of bearings, and one of which is provided with a channel, *b*, while the other carries a socket for the reception of the handle, *h*. The extremity of this latter engages in the groove, *j*, thus limiting the travel of the cock. The shells, *c'* and *b'*, once connected by means of the flanges, *i*, the desired tightness may be secured by screwing them up closer and closer.—*Chronique Industrielle.*

LERICEL'S DRYING APPARATUS.

MR. LERICEL has invented an apparatus for drying by a rapid and continuous circulation of air, which is applicable for all industrial purposes.

The apparatus, which is shown in the accompanying cut, consists of an iron plate chest, in which are placed the materials to be dried, and which communicates with a double-



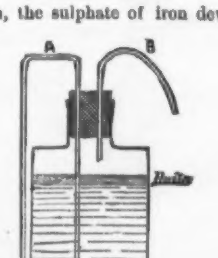
LERICEL'S DRYING APPARATUS.

jacketed fireplace. The external air does not enter the fireplace directly, but passes into the double jacket, where it becomes heated, and then enters at the bottom of the chest, and, following the direction shown by the arrows, escapes at the top. The air thus takes up the dampness of the materials to be dried, and, passing beneath the chest, enters the fireplace.

This apparatus may be employed to advantage in manufactories of rubber surgical instruments, and in soap factories for drying fancy soaps. It is especially adapted for the drying of glues, skins, and other materials that cannot stand heat. It may be regulated so as to operate from an ordinary temperature up to one of 75°.—*Chronique Industrielle.*

SULPHATE OF IRON FLASK FOR PHOTOGRAPHERS.

As well known, the sulphate of iron developer rapidly



spoils, and must be made up fresh but a few hours before it is to be used. It cannot be preserved even in bottles with ground stoppers. Mr. Sterk, however, a distinguished chemist and photographer, has recently devised a simple apparatus, which is designed to keep the solution from contact with the air, and consequently to preserve it for a long time.

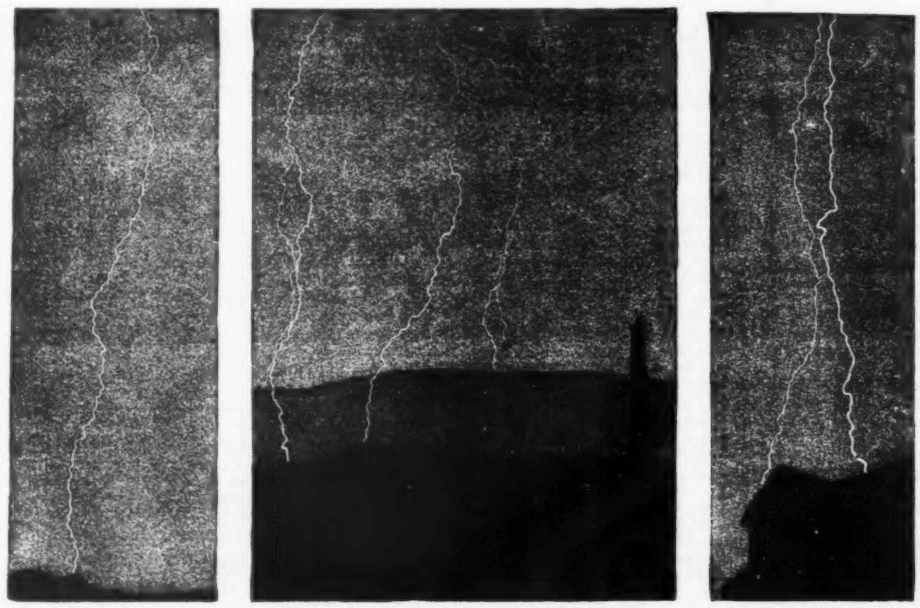
This device, which we find described in *La Nature*, consists of a wide-mouth flask, whose cork is fitted with a glass siphon and bent glass tube. After the solution is put into the flask its surface is covered with a layer of oil, and this serves to prevent all access of air to it. When it is desired to use the liquid the operator has only to blow in the tube, B, which, for this purpose, is provided with a rubber tube. The siphon, A, becomes primed by this means and the liquid begins to flow. To stop the flow it is only necessary to suck through the tube, B, when the liquid will fall back into the flask.

FLASHES OF LIGHTNING INSTANTANEOUSLY PHOTOGRAPHED.

A SKILLFUL Bohemian photographer, Mr. Robert Haensel, has succeeded in taking excellent photographs of those lightning flashes that traverse the atmosphere with their objective exposed from ten o'clock in the evening, when the sky was very black. The apparatus was provided with very sensitive gelatino-bromide plates, upon which the images of the flashes, as they occurred, formed of themselves. Out of ten plates exposed Mr. Haensel obtained only the photographs of which we give accurate figures herewith. The reproductions that we publish were made very skillfully by Mr. Gillot, by means of his *heliogravure* process, and are of the utmost accuracy.

Mr. Haensel, in taking the same points of view during the day time as he did at night, has been enabled to ascertain at what distance from the apparatus the flashes occurred, and estimates it at about 1,700 meters.

As regards the form of the electric spark, the accompanying figures are very interesting to consider. Fig. 1 shows a vertical flash where zigzags are in most cases slightly rounded; to the left of Fig. 2 we remark a flash which is double, and even triple in the center, and, during the same moment, another flash was plowing through the heavens and ramifying. Branches of fire are seen detaching themselves from the central flash, and one of them is losing itself in space.



FIGS. 1, 2, AND 3.—HELIOTYPIC REPRODUCTIONS OF INSTANTANEOUS PHOTOGRAPHS OF LIGHTNING.

fiery zigzags during a space of time so short as to be absolutely inappreciable. This result, which is truly marvelous, will interest physicists, meteorologists, and amateurs in photography, all to the same degree.

Wheatstone has demonstrated by direct and very ingenious experiments that the duration of isolated flashes of lightning does not reach a millionth of a second. From this figure it will be seen what extraordinary sensitiveness is possessed by the new gelatino-bromide plates that permit of operating with certainty under such circumstances. Mr. Haensel has given us the following few details in regard to the process employed by him. On the 6th of July, 1883, the weather being stormy and the heavens being traversed by numerous flashes of lightning, the operator directed his apparatus toward that point of the horizon where the electric manifestations were having their origin, and left the

Fig. 3 shows us two very sharp flashes, which, after remaining nearly parallel, approach each other without mingling and afterward separate at the line of the horizon. One of these has left upon the negative a much more vivid impression than the other. Fig. 4 is an admirable photograph, which represents a many-forked flash in all its beauty. These curious photographs must be considered as still another triumph of gelatino-bromide of silver.—*La Nature.*

CHEMICAL EXPERIMENTS IN THE LANTERN.

THERE is always a charm about a pretty and striking experiment that an audience, whatever its nature, seldom fails to appreciate. Let an experiment be ever so simple or let it be only partially calculated to illustrate the subject of a lecture, it is not only young people who delight in it, but

FIG. 4.—INSTANTANEOUS PHOTOGRAPH OF FLASHES OF LIGHTNING.

"children of a larger growth" will evince an interest in and applaud it. On a good experiment the success of a lecture will often depend, provided it is done on a sufficiently large scale. Even famous men of science look to successful demonstrations to gain the attention of their audiences. And not only in the lecture room, but at home, also, may such experiments be turned to account, and instruction follow what, in spite of all that is frequently said to the contrary, is done quite as much for the sake of amusement.

There is one class of experiments which has hardly received all the attention it deserves—namely, chemical experiments performed in the lantern, an image being thrown on to the screen. Not only are such experiments attractive in themselves, but they may be put to real service in showing on a large scale many of the principles on which the science of photography (to bring the matter home to our readers) depends. The apparatus required is simple and easily constructed, the small amount of trouble involved being amply repaid.

The first desiderata (next to the lantern) are a few suitable cells. We mention two ways in which these may be constructed. The first method is to obtain two pieces of clear glass, preferably thin patent plate of a suitable size. Then cut some narrow strips of a thick plate glass, and smooth the edges by rubbing them down on a piece of flat stone; the polished surfaces of these strips should also be rubbed down to give them a ground surface, which will afford them a stronger hold. The cell may then be put together by warming the glass and applying marine glue, with the aid of a heated piece of iron—an old file, for instance, or, in the absence of anything better, that useful domestic implement, the kitchen poker. One disadvantage of marine glue, however, is that the heat from the lantern, if it is in for a long time, may cause it to leak. Another good way of joining the glass, and one which requires less skill, is to cement it with bichromated gelatine, and expose to light; if this plan be adopted, it is advisable to paint the cemented edges, inside and outside, with sealing-wax varnish or gold size applied with a camel hair pencil. Gold size may itself be used to cement the glass; but except for microscope cells, we do not care for this. A very good form of cell may be made by inclosing two pieces of glass in a wooden frame the size of an ordinary carrier but thicker, these two pieces of glass being separated by a piece of rubber tubing, or better still, a strip of solid rubber such as is used for catapults, bent round to form the bottom and sides; the glass plates are placed sufficiently near together to squeeze the rubber and make a water tight joint. One great advantage of this form of cell is, that it can readily be taken to pieces and cleaned when necessary.

Few of the lanterns now manufactured require any alteration to render them available for this class of work. In most of them the fitting which receives the slide carrier—in this case the cell—is open at the top as well as at the sides; if the lantern does not already possess this convenience, an opening must be cut. A few minor pieces of apparatus required are a small funnel, one or two pipettes, and a thin glass stirring rod.

We give a few examples of the kind of experiments which may thus be shown to a large audience—precipitations, for instance, as by dropping solution of nitrate of silver into a solution of a chloride, or *vice versa*, and subsequently dissolving the precipitate in hypo or the precipitation of mercuric iodide by adding potassic iodide to mercuric chloride. On the screen the particles will appear to move upward instead of falling down; but this only enhances the effect. A very pretty experiment is to add a drop of solution of red prussiate of potash to a weak solution of ferrous sulphate, by way of illustrating iron processes; another pretty effect is, add a solution of a sulphocyanate to a weak solution of ferric chloride; the absorption of iodine by hyposulphite of soda; the bleaching action of such compounds such as sodic hypochlorite on a solution of some dye, such as turmeric or indigo; the effects of acids and alkalies on solutions of blue and red litmus, etc., etc.—*Photo. News.*

SUGGESTIONS IN ARCHITECTURE.

ENGLISH COTTAGES.

THE South cottages, Norbiton Park Estate, Surrey, have been erected on the estate at a cost of about 380*l*. a pair. They contain six rooms, scullery, water closet, and coal cellar, separate entrances. The architect was Mr. T. Lockwood Heward.

COTTAGES, NORBITON PARK, SURREY. THOS. LOCKWOOD HEWARD ARCHITECT

HOUSE AT LONG DITTON.

This house was lately completed from the designs of Mr. J. Nixon Horsfield, architect, of Surbiton.—*The Architect.*

THE OBSERVATORY OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.*

THE measurement of the temperature does not form a service apart at the International Bureau, but the importance of the operations connected therewith, and the precision of the apparatus employed for the purpose, lead us to give a special description of the latter.

The air thermometer is based upon the remarkable principle discovered through the classical experiments of Regnault on the expansion of gases. This illustrious physicist demonstrated, in fact, that the increase in tension that a gas undergoes when heated while its volume is being kept constant is perceptibly proportional to the temperature.

It may be easily conceived that Regnault utilized this property for the measurement of temperatures. The first accurate air thermometer constructed by him consisted essentially of a glass bulb filled with air and connected by a capillary tube with one of the legs of a mercurial pressure gauge. The mercury was kept constantly at the same height in this leg by special arrangements, while the bulb was being exposed to different temperatures.

The tension of the gas at each temperature was then measured by the height of the column of mercury that balanced it.

This instrument, generally employed by scientists, has since undergone numerous modifications, the purpose of most of which has been to obtain great accuracy in the measurement of pressures. Such measurement, which consists in determining the difference in height of the level of the mercury in the two legs of the gauge, presents great difficulties when tubes of large dimensions are used for the gauge, a condition that is necessary in order to avoid the capillary depression of the mercury. In wide tubes the surface of the mercury presents a plain surface, and one so even that it is impossible to distinguish the level of the mercury when it is looked at horizontally. To succeed in doing so, movable points are employed, these being moved gradually near to the surface. Upon then observing the level of the mercury through a spyglass, the point is seen to further and further approach its image, the point of contact between the point and its image exactly indicating the level of the mercury.

The apparatus represented in the accompanying cut is the one that has been constructed for the observatory of the International Bureau. The arrangement that we have just mentioned has been adopted for the pressure gauge readings as well as for the measurement of the atmospheric pressure in the barometer, B B. At the left of the figure is distinguished, in addition, at A, the leg of the pressure gauge which is connected by a capillary tube with the bulb placed in the interior of the heating apparatus. This latter is located in an adjoining room so as not to expose the measuring apparatus to variations in temperature.

After the constants of the instruments have been determined, a comparison of the mercurial thermometers, *tt*, may be proceeded with, the reservoirs of these being placed in the heating apparatus in proximity to the bulb, A, of the air thermometer. The observations consist, on the one hand, in reading the temperature indicated by the mercurial thermometers, and, on the other, in measuring the difference in the level of the mercury in the two legs of the pressure gauge. As the open leg of the latter is submitted to the pressure of the atmosphere, the gauge indicates only the difference between the atmospheric pressure and the tension of the gas contained in the bulb. To obtain the total pressure that balances the tension of the air in the bulb, the barometric pressure must, then, be added to that which is shown by the pressure gauge. The measurement of pressures is effected by means of three horizontal spyglasses movable in a vertical direction along a rod fixed to the pillar shown to the left of the figure. This rod is capable of revolving around its axis. After pointing on the level of of the mercury the spyglasses are turned, without disarranging them, around the said vertical axis in such a way that the marks on the rule over the gauge may be sighted. The spyglasses fixed upon the rod form, after a fashion, a compass that permits of carrying the difference in the mercury's level in the legs of the gauge on to the scale that serves to measure it.

These instruments permit hundredths of a millimeter to be easily measured. Under the ordinary condition of an operation $\frac{1}{100}$ of a millimeter correspond to a variation of $\frac{1}{100}$ of a degree, Centigrade, in the temperature. In order to keep the temperature constant within these limits, vapors of different liquids are made use of advantageously, such as those of ether, methylic alcohol, and common alcohol, whose ebullition occurs at known temperatures. A regular ebullition of these liquids being one of the essential conditions connected with a constancy in the temperature, the arrangement shown in the figure has been adopted. A boiler, *a*, placed in a water bath, *c*, contains liquid whose vapors escape through the tubes, *xx*, and enter the double jacketed heating apparatus. After traversing every part of the latter, including the glass tubes in which are placed the mercurial thermometers, *tt*, the steam makes its exit through the tubes, *yy*, and liquefies in the condenser, R, whence the liquid returns to the boiler through the tubes, A. Other conduits serve likewise to restore to the boiler the portions of steam that condense on the way or in the apparatus, so that the same quantity of liquid may serve for quite a long time. The water bath, *c*, which furnishes the heat necessary to keep up the ebullition of the liquid employed is heated by steam from a small boiler, F, placed a short distance away.

The arrangements that we have just rapidly described permit of determining to within nearly one-hundredth of a degree the difference between the operation of the air thermometer and the mercurial one.

It will be seen from the summary descriptions that precede how important is the new and remarkable international establishment which is now founded in the vicinity of Paris. Having thus given a general idea of its apparatus and of the exceptional resources at its disposal, as regards the special object of its labors, let us say a word as to the interest that these latter present, and as to the phase that they have now reached.

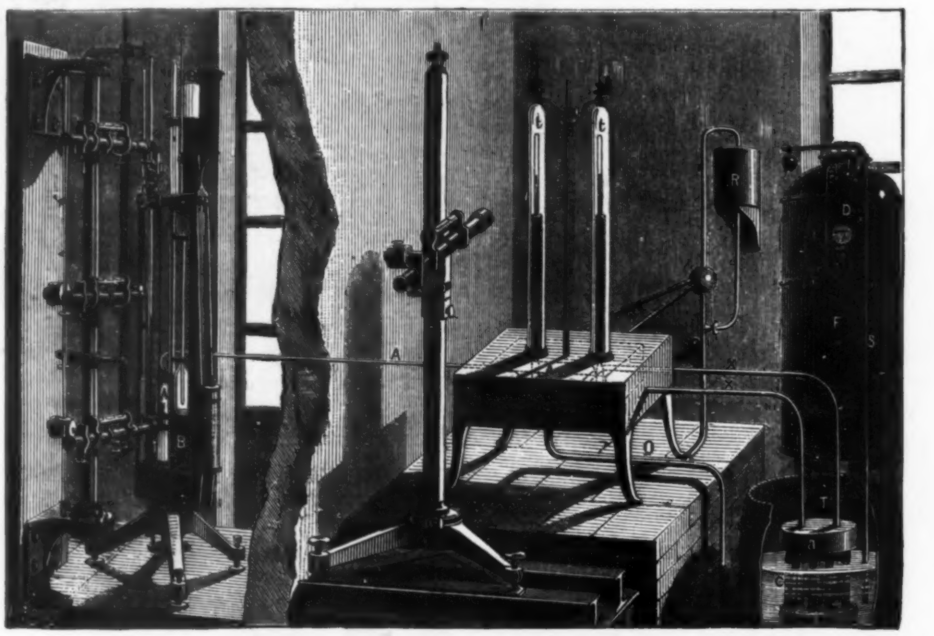
The signature of the Meter Convention of 1875 will necessarily be followed, as a consequence, in the near future, by the adoption of the metric system by all the nations of the civilized world. Such a result is not to be disdained. By establishing a new bond of union between nations, and by favoring international relations, the universal introduction of a uniform system of weights and measures will doubtless powerfully serve the interests of civilization. But this is not the only nor even the principal interest attached to this international work. It was not, as may well be imagined, for the needs of commerce and the industries that it was necessary to get up so complex and so perfect an equipment, for the interest of the Bureau's labors is, before all things, scientific. Science is becoming more and more discontented with *almost*, and, in all the branches possible, is seeking rigorous accuracy. Now, the International Bureau will furnish it not only with exactly controlled and verified standards of measurement, but also with a large number of physical constants determined with the greatest care and under conditions as perfect as possible. Among all the sciences, the one that will be most benefited by the new institution is geodesy. One of the causes, in fact, that most prevents an exact knowledge of the figure of our globe being obtained is the uncertainty that still exists in regard to the relative values of those measuring apparatus which, having been employed for measuring the different *bases*, have served as starting-points for the triangulations that have been made upon various parts of the earth's crust. A minute study of such apparatus, hereafter centralized in the Breteuil laboratories, will cause these unfortunate discordances to disappear, and give a surer base for the labors of surveyors. As much may be said regarding the study of the variations in weight by means of the pendulum. The International Commission has decided to take as its starting-point for the new metric units the standards that already exist, that is to say, the meter and the kilogramme of the Archives of France, in their present state. This decision must be approved of without restriction. While rendering full homage to what, at the end of the last century, there was of great and useful in the idea of seeking a base for universal measurements in the dimensions of the globe that bears the entire human race, it must be recognized to-day that the essential thing is not that the meter shall possess so many *microns* (*i. e.*, $\frac{1}{1000}$ mm.) more or less, but that the whole world shall have the *same* meter, and that the copies of it that are distributed shall all be exactly equal to the standard, or rather accurately determined with respect to said standard. To wish, moreover, that the length of the meter shall exactly represent its theoretical definition would surely be to expose it, in measure as geodesic science makes progress, to periodical retouchings or modifications—one of the worst of inconveniences for a fundamental unit.

Such a starting-point adopted, it first became a question of making an international meter and kilogramme, that is to say, as exact copies as possible of the meter and kilogramme of the Archives, which should present greater security than these latter, as regards their indefinite preservation and their precision for comparisons, and which, belonging in common to all the nations who ratified the Convention, should be preserved at the Bureau and thereafter serve as prototypes or bases for a system of weights and measures for the entire world. It afterward became a question of making a sufficient number of meter measures and kilogramme weights for distribution among the contracting nations, after comparison with the international standards.

The choice of material of which these new standards were to be made, the form to be given them, the nature and arrangement of their outlines, the processes to be employed in comparisons, and a host of accessory questions connected therewith were the object of long and learned studies, in which, besides the International Committee, the French section of the International Commission (composed of the most competent French savants) took a large part. It would take too long to pass in review, even as briefly as possible, each of these points. Suffice it to say that the material adopted for the new standards—meter as well as kilogramme—is platinum alloyed with $\frac{1}{10}$ of iridium to give it greater hardness and durability. The labors that gave rise to the selection of this material brought about remarkable improvements in the processes of treating and purifying platinum and the metals that accompany it in the mine. It is impossible to refer to these without recalling to memory the regretted Sainte Claire Deville, who gave up the last years of his life to such studies with indefatigable devotion.

The form chosen for the meter measure is that of a bar whose section has the shape of an X, or rather of an H, whose uprights recede from each other at the top and bottom. This form, which is calculated in such a way as to furnish a maximum rigidity for a given quantity of material, presents still other advantages upon which we cannot expatiate. It is 1·02 m. in length, and, upon the upper surface of the transverse leg (that is to say, upon the plane of the neutral fibers), there are traced two very fine lines, whose distance to zero represents exactly the length of the meter. It is, then, a meter measure provided with a scale. The meter measure of the Archives, on the contrary, is a bar that has exactly the length of a meter from one extremity to the other, the meter being given, then, by the distance which separates, at zero, the centers of the two terminal planes. The comparisons between the International meter measure and that of the Archives were made at the Conservatoire des Arts et Metiers, and those between the International kilogramme weight and that of the Archives were made at the Observatory. These labors, which took several months, were performed through the care and under the direction of a mixed commission composed of members of the International Committee and of the French section, and presided over by Mr. Dumas, the perpetual secretary of the Academie des Sciences, who represents France in the Committee. The manufacture of the national standards is under way, and the final comparisons will begin before long.—*La Nature.*

* Continued from SUPPLEMENT No. 407, page 6488.



THERMOMETRIC AND BAROMETRIC APPARATUS AT THE OBSERVATORY OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

EDISON INCANDESCENT SYSTEM IN GERMANY.

A cable dispatch from Berlin, January 24, says that, in the suit there between the Edison and Swan incandescent systems, the former has been victorious. The question involved was as to the priority of discovery of the carbon filament, and its practical use as at present. The defense had the right to prove that somebody, or anybody, had succeeded in this before Edison, which would have vitiated his patent there, but the failure to do this in the German courts places the Edison system in a very strong position as bearing upon any future litigation, either in Europe or in this country.

ELECTRICAL CONDUCTORS.

AT a time when the only demand for certain metals and materials which shows evidence of rapid growth is that caused by the expansion of modern applications of electricity, the following record of experience will be welcomed, particularly as it comes from so eminent an authority as Mr. W. H. Preece, the chief electrician of the English Post Office Department. In a paper read before the Institution of Civil Engineers, Mr. Preece states that the first aerial conductors were made of copper, and the first gutta-percha covered wires were of iron; but the positions were soon changed, copper being universally used for insulated conductors, and iron, until lately, for overhead lines. Sir William Thomson detected great variations in the quality of copper, and Mathiessen detected the causes, and established a standard of purity.

Such improvements have been made in the quality that copper is now twice as good as it was in 1856. Increased speed of working, improved efficiency of apparatus, and reduced waste of energy have followed the great increase in the purity of copper. Temperature is a disturbing agent in the conductivity of the wire. Resistance increases more than 20 per cent. between winter and summer temperatures. Copper has recently been much used for aerial lines. It is less attacked by acids, and has great durability. Hard drawn wire is now produced which has a breaking strain of 28 tons on the square inch, iron wire giving only 22 tons on the same area. Age does not seem to affect its quality, nor does it appear to be influenced by the currents of electricity employed for telegraphic purposes. The conductors of all cables remain constant. Lightning is supposed to render it brittle. The ultimate effect of the powerful currents employed for electric lighting is not yet known.

The size of conductors is controlled by commercial considerations. Sir William Thomson has laid down the law that should control the size of leads for electric light, while that for cables follows strictly theoretical conditions. The best copper for electrical purposes comes from Japan, Chili, Australia, and Lake Superior; but much pure copper is obtained by electro-deposition, either directly from a solution, or by using impure copper as the anode in a depositing bath. Electro-deposited copper has not the strength of ordinarily refined copper. The electrical resistance of commercial iron is from six to seven times that of copper, but its variation, due to the presence of impurities, is even greater. The weight of a cylindrical wire one mile in length, and giving one ohm resistance at 60 degrees Fahr., is called an ohm mile. While the first iron wire was specified to give an ohm mile of 5,500 pounds, it is now obtained as low as 4,520 pounds, and the maximum resistance is specified as 4,800 pounds. The ordinary best puddled iron is at present used only for fencing purposes, but a mild English Bessemer steel is largely used for railroad telegraphs and for stays. However, the resistence is very high, owing to the presence of manganese.

The wire used by the Post Office is made from Swedish charcoal iron, with an ohm mile resistance of about 4,520 pounds. Swedish Bessemer, or a specially prepared low-carbon English Bessemer, has been adopted by the Indian

government, with an ohm mile resistance of about 5,000 pounds. Cast steel wire, with a breaking weight of about 80 tons to the square inch, has been adopted on the Continent for telephone currents, with an ohm mile resistance of 8,000 pounds, while in England, where speed of working is the prime consideration, and length of span is negligible, electricians are satisfied with a breaking strain of 22 tons on the square inch. In the Colonies, where lon. spans are essential, and speed of working is not so important, the specification is 30 tons on the square inch. The electrical conductivity of iron wire increases with the percentage of pure iron, except where the percentage of manganese is high. An increase in the percentage of manganese augments the electrical resistance considerably more than an increase in the percentage of sulphur or phosphorus. The durability of iron wire is maintained by galvanizing. When the galvanized wire is to be suspended in smoky districts, it is additionally protected by a braided covering, well tarred. In some countries, galvanizing is not resorted to, but dependence is placed on simple oiling with boiled linseed oil. Such a wire was erected in 1856 between London and Crewe, but the result was very unsatisfactory. More recently—1881—the experiment has been repeated with a similar result. In a climate like that of England, galvanization is imperative.

But it is not alone in smoky districts that iron wire decays. It suffers much along the sea shore. The salt spray decomposes the zinc oxide into soluble compounds, which are washed away and leave the iron exposed, and this is speedily reduced to mere thin red lines. Where external decay is not evident, time seems to have no apparent effect on iron wire. Thirty-nine years of incessant service in conveying currents for telegraphy have not apparently altered the molecular structure of the iron wires in the open country on the London and Southwestern Railroad. Swedish charcoal iron is imported either in bloom or in rods, principally in rods. Each rod is rolled down to about 0·26 inch diameter, and weighs on the average about 1 cwt. Iron wire could be rolled and drawn into coils 0·171 inch in diameter, weighing 400 pounds and measuring one mile; but 110 pounds is about the best practical limit for transport and use. The Swedish iron owes its value, not only to its comparative purity, but to the fact that it is smelted and puddled entirely with charcoal. The best qualities are a mixture of various ores, and they are known by various brands, the conditions determining those brands being secret.

The operation of testing is a most important one, and requisite not only for the user, but also for the manufacturer. Flaws, impurities, faults, notwithstanding the greatest care, will occur, and they can be detected only by the most rigid examination and tests. Tests are mechanical and electrical. The mechanical tests embrace one for breaking strain, another for elongation, and a third for resistance to torsion. For hard steel wire in place of the torsion test, it is usual to specify that the wire shall bear wrapping around its own diameter and unwrapping again without breaking. The electrical test is simply that for resistance. One-thirtieth of a mile of the wire to be examined is wound around a dry wooden drum, and its electrical resistance is taken in ohms by means of a Wheatstone bridge. Galvanization is tested by dipping in sulphate of copper and by bending or rolling around a bar of varying diameter, according to the size of the wire. Special machines have been constructed for the mechanical tests, the condition to be fulfilled being that for the breaking strain the increasing load or stress shall be applied uniformly. without jerks or jumps, and the elongation machine shall correctly register the actual stretch without the wire slipping.

The resistance to torsion to the wire is determined by an ink mark which forms a spiral on the wire during torsion, the number of spirals indicating the number of twists taken before breaking. The perfection to which the manufacture of iron wire has been brought is very much due to the care bestowed upon the specifications by the authorities of the Post Office. The standard has been gradually raised until it has become very high. Many administrations object to the expense of thorough inspection, with the result that they are the recipients of the rejected material of those who do rigidly inspect. One break in the wire costs far more than its inspection, and one extra ohm per mile affects the earning capacity of the wire in inverse proportion. It is, however, necessary to remark that the mechanical quality of charcoal iron wire sometimes changes with time—its electrical quality remaining unaffected. Tests repeated at some subsequent period may therefore be deceptive unless allowance is made for the effect of time. Bessemer or homogeneous iron wire as a rule improves in its mechanical properties by being kept in stock.

The Post Office authorities have decided to abandon a gauge altogether as applied to conductors, and to define size by diameter and weight. In future, all copper wires will be known by their diameters in "mils," or thousandths of an inch, and all iron wires by their weight in pounds per mile. Steel wire is used for long spans, or for places where great tensile strength is needed; but it is for the external strengthening of deep sea cables that steel wire is principally adopted. It was first employed in the Atlantic cable of 1865 for this purpose. It has since been generally used for deep sea cables. The usual diameter is 0·099 m., and it is specified to bear a breaking strain of 1,400 pounds, which is equivalent to 81 tons on the square inch. Steel wire has been produced giving a much higher tensile strength. A compound wire of steel and copper was introduced in America about 1874, and it has been extensively tried in both hemispheres, but without success. Recently, a compound wire has been erected between New York and Chicago, a distance of 1,000 miles, giving only 1·7 ohm resistance per mile. It has a steel core 0·125 inch in diameter, and is coated with copper electrolytically to a diameter of 0·25 inch. It weighs 700 pounds per mile. Hard drawn copper, or silicious bronze of a much lighter character, would be equally efficient.

Phosphor bronze, the hard mechanical qualities and great resisting powers of which are well known, was introduced for telegraph wire about five years ago. Several lengths were erected by the Post Office. Two long spans cross the channel that separates the Mumbles Light House from the headland near Swansea. The object in view was to obtain great tensile strength, with a power to resist oxidation, especially active where the wire is exposed to sea spray. This was done in 1879, and in November, 1883, not the slightest change was noticeable in the wire. But phosphor bronze, though extensively used, has high electrical resistance; its conductivity is only 20 per cent, that of copper. Moreover, the phosphor bronze supplied is irregular in dimensions and brittle in character. It will not bear bends or kinks. A new alloy, siliceous bronze, has recently been introduced to remedy these disadvantages. Phosphor bronze has disappeared for telegraph wire, and has been replaced by silicious bronze. The electric resistance of silicious bronze can be made nearly equal to that of copper, but its mechanical strength diminishes as its conductivity increases.

Wire whose resistence equals 90 per cent. of pure copper gives a tensile strength of 28 tons on the square inch; but when its conductivity is 34 per cent. of pure copper, its strength is 50 tons on the square inch. Its lightness, combined with its mechanical strength, its high conductivity and indestructibility, render it eminently adapted for telegraphs.

If overhead wires were erected of such a material, upon sightly supports, and with some method, there would be an end to the meaningless crusade now made in some quarters against aerial lines. These, if constructed judiciously, and under proper control, are far more efficient than underground lines. Corporations and local authorities should control the erection rather than force administrations to needless expense and to reduced efficiency by putting them underground. Not only do light wires hold less snow and less wind, but they produce less electrical disturbance, they can be rendered noiseless, and they allow existing supports to carry a much greater number of wires. German silver is employed generally for rheostats, resistance coils, and other parts of apparatus in which high resistance is required. It consists of copper four parts, nickel two parts, and zinc one part. It possesses great permanence, and the variation in its resistance due to changes of temperature is small. The effect of age on German silver is to make it brittle. Mr. Willoughby-Smith has found a similar change with age even with wire drawn from an alloy of gold and silver.

The form and character of electrical conductors must vary with the purposes for which they are intended. For submarine cables and for electric light mains, where mechanical strength is not required, and where dimesions are of the utmost consequence, the conductors must be constructed of the purest copper producible, for copper is the best practical material at command. For aerial lines, they must not only have great tensile strength, but in these days of high speed apparatus they must have high conductivity, low electrostatic capacity, expose to wind and snow the least possible surface, and must be practically indestructible. Iron has hitherto occupied the field, but copper and alloys of copper seem destined in many instances to supplant that metal, and to fulfill all the conditions required in a more efficient way, and at no greater cost per mile.

REYNIER'S STANDARD PILE FOR THE MEASUREMENT OF ELECTROMOTIVE FORCES.*

As well known, the electromotive force of single-liquid couples is very variable—diminishing on the closing of the circuit and increasing when the pile is at rest. For the same voltaic combination it appears greater with a positive electrode whose surface is relatively great as compared with that of the negative. So the *apparent* electromotive forces of such couples change with the construction of the pile, the circumstances connected with the experiments, and the methods of measurement employed.

Among all the values that the electromotive force of a couple may assume, there are two which it is requisite to know—the greatest and the least. I believe that I have succeeded in obtaining with certainty the measurement of these two extremes by means of the two models of apparatus that are shown in the accompanying figures.

The *maximum couple* (Fig. 1) has for positive electrode a plate, Cu, of plaited and open-work copper having an effective surface of 30 square decimeters, that is to say, three hundred times greater than that of the negative, Zn. This latter consists of a wire 3 mm. in diameter, which runs to the center of the vessel, A. This wire, which is of zinc, may be raised out of the liquid and be held by a pressure screw that acts upon the sleeve in which it is guided. The insulating piece, B, fixed upon the electrode, prevents any derivation through the cover, and serves as a stop when the negative wire is raised in order to put the pile at rest.

This couple, whose capacity is 800 cubic centimeters, has a resistance of from 0 ohm to 2 to 4 ohms according to the liquid employed—a value that need not be considered when the total resistance of the galvometric circuit reaches several thousand ohms. Its electrometric force loses less than one-hundredth of its value by a work of two hours at an intensity of *one milliampere*. The pile, then, may be considered as constant during the few minutes necessary for the measurement of a potential by known galvanometric methods.

The *minimum couple* (Fig. 2) has the same external dimensions as the other, but the negative electrode has here the greater surface (about 5 square decimeters). The positive electrode is a wire 0·5 mm. in diameter whose immersed surface is less than one square centimeter. The resistances of this pile are nearly the same as those of the other.

In order to measure the minimum electromotive force of the couple, the two wires that run to the galvometer are put in communication with the two terminals of a short circuit key. The latter is closed for a few hours, then opened, and a measurement at once made. This gives a very approximate, if not exact, value of the difference of potential sought. As the positive electrode of this couple has a very small surface, the products of oxidation formed by the air occur in very small quantity, and are completely reduced by a closing in short circuit and do not form again quickly enough to perceptibly affect the measurement. The electromotive force of the standard depends naturally upon the liquid employed. That used here is a solution of sea salt. With this the elecromotive force of the couple is 0·82 volt.

Numerous and varied measurements have shown that this value exactly is found under all circumstances, and that it remains fixed when the temperture of the apparatus varies between +5° and +40° C.

* From a note presented by Mr. E. Reyneir to the Société Francaise de Physique.

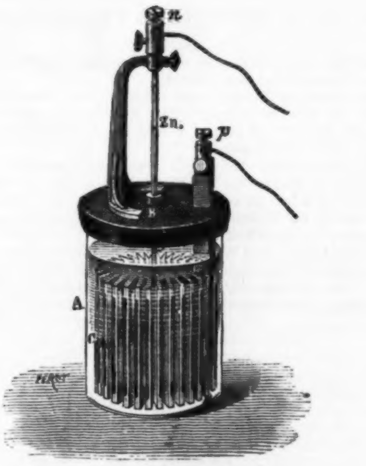


Fig. 1.—MAXIMUM PILE.

Fig. 2.—MINIMUM PILE.

THE ELECTRIC INCUBATOR.

In an apparatus devised by a Berlin firm, electricity is applied to heat an incubator. Fig. 1 shows a basket filled with hay or fine straw upon which the eggs are laid. The cover, Fig. 2, consists of layer of soft down attached to circular box containing coils of wire. The latter are heated by an electric current whose temperature is regulated by a thermometer placed on the cover. When the heat becomes too great, the rise of the mercury cuts the coils out of circuit and allows them to cool. Fig. 3 represents a coop for the chicks, in which the cover can be raised to accommodate with their growth. The only attention required is to sprinkle the eggs with fresh water and to turn them once a day.—*Wiener Landwirthschaftliche Zeitung.*

THE ELECTRIC INCUBATOR.

[Continued from SUPPLEMENT No. 405, page 6467.]

HISTORY OF THE ELECTRIC TELEGRAPH.

AT the time of his arrival in England, Cooke brought with him, in addition to his telegraph, an alarm which was, like the preceding, moved by a clockwork mechanism on the removal of a detent, but in which such removal was effected by the action of an electro-magnet upon its armature. This is the first example of the use of the electro-magnet in telegraphy. Desirous of reaping all the advantage possible from the apparatus in his hands, he endeavored to put himself in correspondence with some man of science who might be able to supply what he lacked in scientific knowledge. He first addressed himself to Faraday, but unsuccessfully, and then to Wheatstone, whom he called upon on February 27, 1837. His co-labors with the latter began soon after, in May, and, on the 12th of June, 1837, the two associates filed a caveat which was confirmed on the 12th of December by

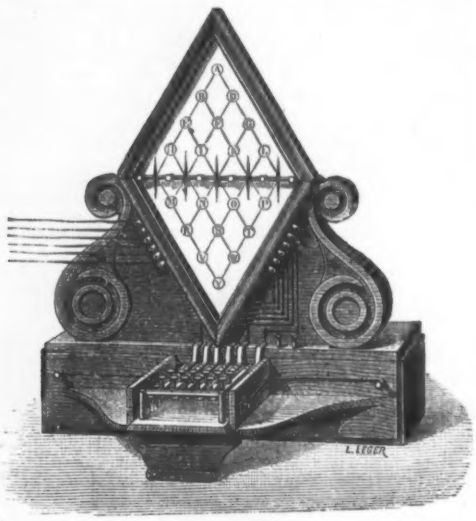


FIG. 16.—COOKE & WHEATSTONE'S FIVE-NEEDLE TELEGRAPH.

the issue of a patent to them. This latter bore as its title: Improvements introduced into Telegraph Signals." So its authors in no wise claim the original invention.

The patent included the five needle telegraph, the four-needle telegraph, and an alarm.

Before becoming a five needle telegraph, Cooke's three needle apparatus had been slightly improved in April, 1837. The pile had been separated, the special commutators had been replaced by a general commutator, the currents were sent by means of keys, as in the Alexander apparatus, the wires had been diminished in number and half of them replaced by a single return wire, and finally there had been added a fourth galvanometric helix, the needle of which was designed to close a local current and actuate the alarm.

This use of a local current, which here appears for the first time, and is in fact the principle of the relay, was the first improvement due to the co-labors of Cooke and Wheatstone. Cooke's call itself was soon improved, and the clockwork movement entirely done away with. A vertical galvanometric helix contained a needle that carried a balanced arm which was provided at one of its extremities with a fork. When the needle was deviated, this fork dipped into two mercury cups and thus closed the current from a local pile on an electro-magnet. The armature being attracted, a small rod that it carried struck directly against a bell, and then, as soon as the current ceased to pass, was drawn back by a spring. It was thus easy to strike several strokes on closing the circuit several times.

The five needle telegraph appeared as shown in Fig. 16. Behind a lozenge-shaped tablet, there were 5 galvanometric helices. In front there were 5 needles that corresponded to the 5 magnetized needles of the helices. In the extreme front there was a key board composed of 6 strips of metal.

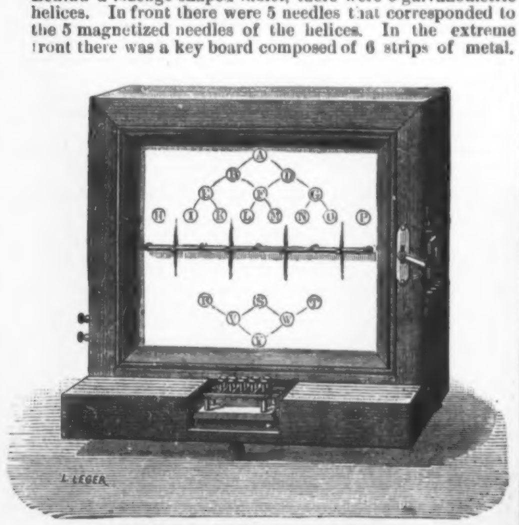


FIG. 17.—COOKE & WHEATSTONE'S FOUR-NEEDLE TELEGRAPH.

From five of these there started wires which traversed the five galvanometers, ran to the other station, traversed the galvanometers of another apparatus like the first, and ended in the strips of a second key board. The sixth strip of each key board was connected with the return wire.

In each key board, these metallic strips were in permanent contact at their front extremity with a metallic crosspiece placed over them. Beneath, at a short distance, there were two other crosspieces, one of them connected with the positive and the other with the negative pole of the pile. Each strip carried two ivory-headed buttons, each situated above one of these lower crosspieces. When one of these buttons was depressed, its rod descended at first a little beneath the strip, and then the latter itself gave way and separated from the upper crosspiece, so that the little rod touched that of the lower crosspieces which were exactly beneath it.

If, then, two strips were thus depressed, care being taken to touch two buttons that did not correspond to the same crosspiece, the current entered through one of the strips, traversed one of the galvanometers of the first apparatus, passed through the corresponding galvanometer of the second apparatus, reached the upper crosspiece of the latter's key board, passed through a second galvanometer and the corresponding one of the first apparatus, and returned to the second depressed button. Two needles were then set in motion in the same way in each of the tablets, and their meeting point designated a letter. Supposing that the buttons were numbered, and that a table gotten up beforehand showed the two that were to be depressed in order to obtain

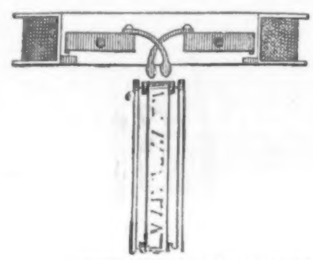


FIG. 18.—STEINHEIL'S TRANSMITTER.

a desired letter, it is easy to understand how the transmission of dispatches was effected.

The four needle apparatus (Fig. 17) was based upon absolutely the same principle. The number of letters was likewise 20, but two of them—P and H—were designated by the motion of a single needle.

The five-needle telegraph was employed on the Great Western Railway, but it still embraced as yet too large a number of wires to render it practical, and, moreover, at this epoch, considerable progress had just been made in Germany by Steinheil as regards the reduction of these.

While Cooke and Wheatstone were introducing the needle telegraph in England, and were unconsciously pursuing a road that was but slightly different from that marked out by Schilling, Carl August Steinheil, a professor at Munich, was

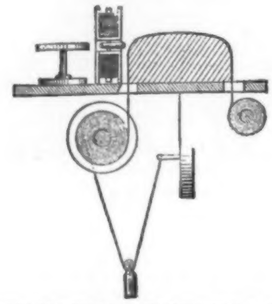


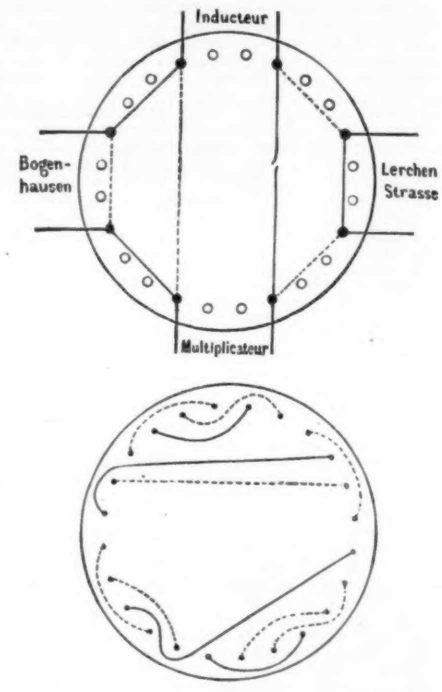
FIG. 19.—STEINHEIL'S RECEIVING APPARATUS.

applying the idea of Gauss and Weber, as to the use of induction currents, in the construction of a writing telegraph.

His apparatus had the form of a table (Fig. 22), which carried, on the one hand, a transmitter, and on the other a receiver.

The transmitter was a sort of Clarke machine, and consisted of a powerful vertical magnet, in front of which could be revolved in either direction, by means of a horizontal rod, bobbins provided with soft iron cores and wound with very fine wire. The two extremities of the wire, issuing vertically from their axis, were bent into a mercurial commutator. The two halves of the latter were each united to one of the line wires and came in communication with the wires of the generator only at the moment at which the current produced was maximum. During all the rest of the period of one rotation of the bobbins, the two portions of the mercury were united by a bridge, so that a current coming from the line could traverse the commutator without passing through the bobbins. It may be conceived, by turning the lever, from right to left for example, that a current was set up in a certain direction, and that, on turning it the other way, the current was in the opposite direction, so that it was possible to produce two distinct effects on the receiver. This possibility was utilized by the aid of a galvanometric helix, A, containing two small magnets movable around vertical axes, *a* and *a'*. These two magnets were turned in an opposite direction, and held in position by two other magnets which acted as directors and were placed behind the helix. Each of these magnets (Fig. 18) carried at one of its extremities a small ink cup, and at the other abutted against a stop.

Each magnet, then, could be deviated only by one direction of current, and its motion could only occur to one side. At each motion its ink cup marked a dot upon a paper band that was unwound uniformly by means of the very simple mechanism shown in Fig. 19. These dots could, then, be



FIGS. 20 AND 21.—STEINHEIL'S COMMUTATOR.

traced in two lines, and the emissions of currents to the transmitted were so combined as to produce upon the band of the receiver groups of slightly spaced dots, each of which designated a letter. The name *Steinheil*, for instance, was written as follows:

s t e i n h e i l

With the German alphabet and the nine figures, no sign required more than four dots, and a transmission of 92 words required but a quarter of an hour.

Steinheil also made an acoustic telegraph of his apparatus by placing in front of the magnets of the multiplier two small bells of different tones, against which the magnets struck. An analogous arrangement, which served as a call, is shown under two forms at B and C in Fig. 22.

The work of constructing and setting up the apparatus was finished in July, 1837. There were three stations, one—the principal—at the cabinet of physics of the Academy, another at the observatory of Bogenhausen, and the third at Steinheil's house in Lerchenstrasse. The line between the Academy and Bogenhausen was formed of two copper wires of a total length of 30,500 Paris feet, and weighing 210 pounds. These wires were stretched from one steeple to another, and, where the distance between two spires was too great, were supported by poles forty or fifty feet in height. These poles, which were 600 to 800 feet apart, carried at their extremities wooden crosspieces surrounded by felt as an insulator. The line between the cabinet of

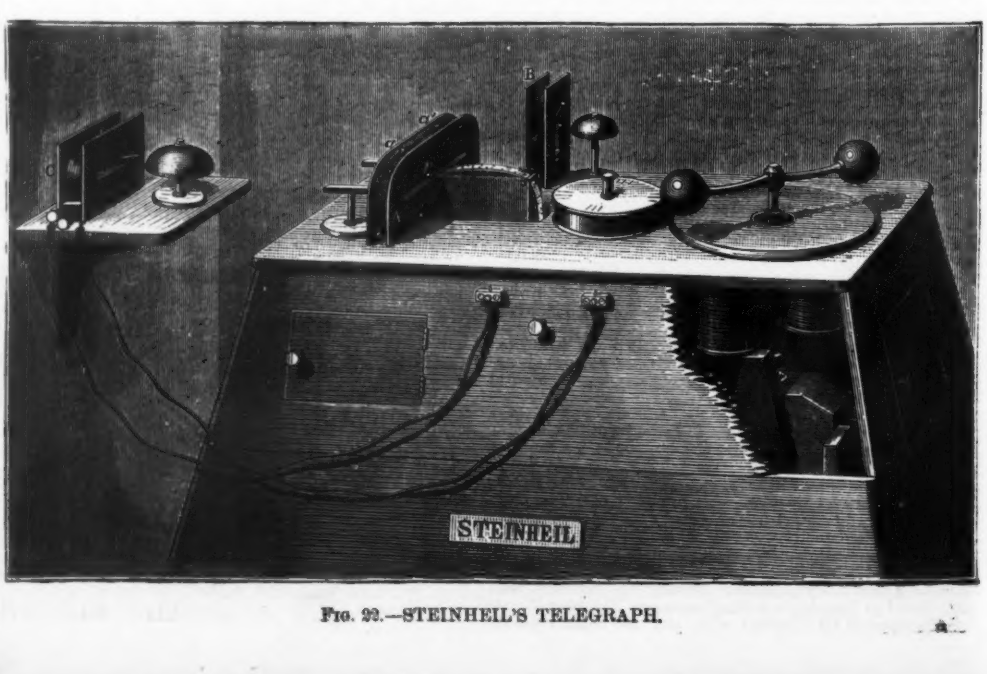
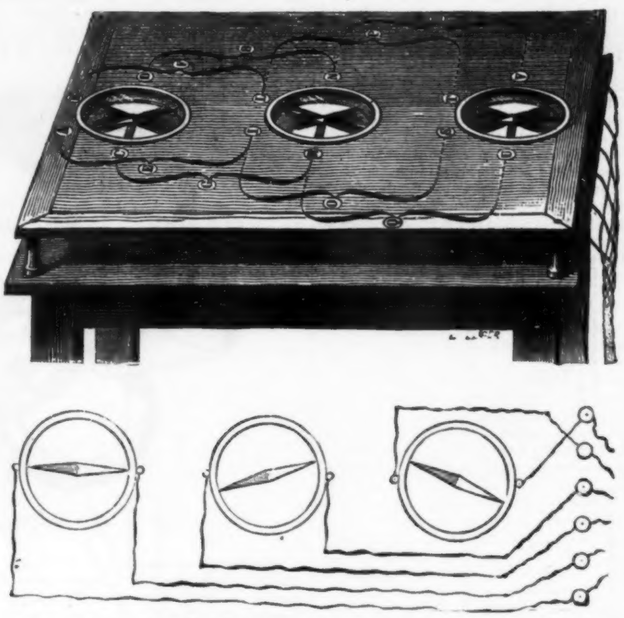


FIG. 22.—STEINHEIL'S TELEGRAPH.

physics and Lerchenstrasse was formed of two iron wires having a total length of 6,000 feet. Finally, there was still another and an accessory line of 1,000 feet, which was contained in the Academy buildings, and which connected the cabinet of physics with the work room connected with it. This line was connected with the apparatus only at certain intervals.

In order to put the central apparatus at the cabinet in connection with either Bogenhausen or Lerchenstrasse, a commutator was employed which possessed the form of a flat copper box, and was placed in the center of the table. (Fig. 22.)



Figs 23 and 24.—MAGRINI'S TELEGRAPH.—THE RECEIVER.

The lower part of this box was formed of a wooden disk provided with 8 apertures which were filled with mercury. The wires of the inductor, as shown in Fig. 20, ended in two of these cavities, and those of the multiplier in two opposite ones. Two other apertures were connected with the Bogenhausen line, and the two opposite them with the Lerchenstrasse station.

If we suppose, now, that the cups are connected with each other by conductors, as shown by the dotted lines in the figure, the currents from the inductor will traverse at once the multiplier and the apparatus of the two other stations. If the connection is made only in the direction of the dotted lines, the Bogenhausen station will be excluded from the circuit; but if, on the contrary, the connections are made in the direction of the unbroken lines, it is the Lerchenstrasse station that will be thrown out of the circuit. If, finally, the cups are connected in the direction of the vertical lines, the inductor and multiplier will be directly connected with each other.

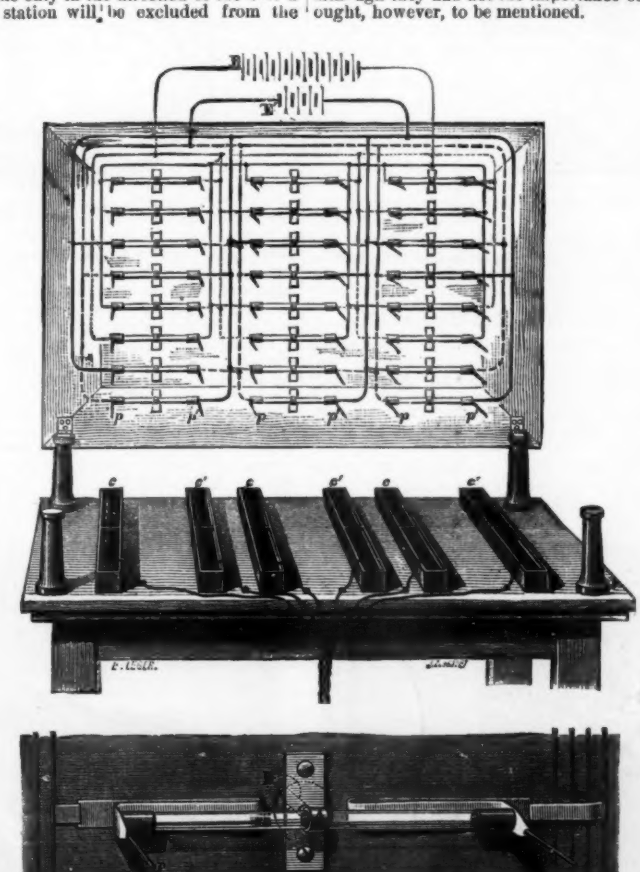


Fig. 25.—MAGRINI'S TELEGRAPH.—THE MANIPULATOR.

In the Steinheil apparatus all such combinations could be effected by means of the upper part of the commutator—another wooden disk into which were set wires, as shown in Fig. 21. The extremities of these wires, 24 in number, dipped into the mercury cups and into apertures formed between these, according to the way in which the upper disk was revolved. Datum points marked on the external part of this cover indicated, for such or such a combination, the position necessary to give it relative to a dash marked on the tables.

In 1838, after fruitless endeavors to use the rails of railways as conductors, Steinheil was led to employ the earth itself, and, in each of his lines, substituted this for the return conductor by putting the wires of the apparatus that had previously been connected with this conductor in connection with plates of copper buried in the earth.

This important simplification had already been effected when the apparatus was described before the Academie des Sciences of Paris, on the 10th of September, 1838.

Steinheil, then, introduced into telegraphy two important improvements, one in the construction of the first writing telegraph capable of working practically, and the other in the reduction of the line wires to a single one by using the earth as a return conductor. It may be certainly said that he contributed to a large degree in the development of telegraphy. The use of the magnetized needle as a receiver gave rise at the same epoch to a few other telegraphs, which, although they had not the importance of the one just cited, ought, however, to be mentioned.

The most interesting of these is the telegraph of the Italian Antoine Magrini, a little-known apparatus, which we do not find described in treatises on the telegraph, but which figured in the Paris Exhibition of Electricity in 1881, among the instruments exhibited by the Institute of Physics of the University of Padua, with this mention: "Telegraphic apparatus constructed in 1837."

The description that we shall give is based upon a careful examination of the apparatus itself.

The receiver (Fig. 23) consisted of a horizontal table, about one meter in length by 0·6 m. in width, which carried three galvanometers whose needles were capable of making two deviations on each side of their normal position—a strong one and a feeble one. These four positions of the needle indicated in each galvanometer a different letter, which was marked on the table. Thus, the letters indicated by the first galvanometer were A B C D; those corresponding to the motions of the second needle were I L M N; and those designated by the third were S T U V. In addition, the needles were capable of being employed in pairs at the same time, and, in this case, a brace that started from the two positions of their points indicated in its center the letter designated.

In this way, for example, F corresponded to two slight deviations, to the right of needles 1 and 2, H to two strong deviations, in the same direction, of this same needle; O was represented by two slight deviations, to the left, of needles 2 and 3; and R by two strong deviations of these same needles to the right.

The three galvanometers, which were independent of each other, as shown in the diagram in Fig. 24, each furnished two wires to the line, and, in order to transmit to their needles the positions that we have just indicated, employed two piles, one of them strong and the other weak, and a manipulator, which, though quite complicated, was very ingenious (Fig. 25). This manipulator consisted of a table of nearly the same dimensions as that of the receiver, and carried six mercury troughs, *c c, c′c′*, . . . in which ended the six line wires, the two to the left, for example, corresponding to the wires of the first galvanometer, and so on. A little above these troughs there was a board that formed the top of the table and carried a series of buttons marked with the letters of the alphabet. Each of these buttons served to depress toward the troughs a system that is shown at the bottom of the figure. The rod of each button, B, terminated underneath the cover in a collar, A, that held a glass tube, and this latter carried at its extremities two points, P and P′. Strips of brass doubled over on themselves, and fixed on the one hand to the points and on the other to the table, formed springs that held the points, P P′, raised, while at the same time allowing them to descend into the mercury when the button, B, was depressed. The top of the table carried 24 buttons, and its under surface was provided with as many corresponding tubes arranged in three vertical rows of 8 tubes each—one for the maneuver of each galvanometer. Each of the four conductors coming from the piles, E (strong) and E′ (weak), divided along the under surface of the table into a sort of four toothed fork, as may be seen in the figure, where the fine lines (broken and unbroken) correspond to the poles of the weak pile.

The three series of point-carriers were placed between the teeth of this quadruple fork, and the spring of each point was connected to one of the conductors in such a way that a depression of any given point-carrier produced upon the galvanometer corresponding to its series a determinate deviation. Let us, for example, take the first series to the left, which we will suppose corresponds to the first galvanometer. The first point-carrier (above) was connected to two wires coming from the strong pile, and the second to two wires of the same origin, but of opposite direction; the third point-carrier was connected to two wires coming from the poles of the weak pile in such a way as to produce a deviation in the same direction as that of the first point-carrier; and the fourth communicated with the wires of the same origin, but of different direction. The four following point-carriers had the same communications as the preceding, that is to say, the fifth was connected with the same wires as the first, the sixth with the same wires as the second, and so on. If, then, the button of the first point-carrier was depressed, the first galvanometer was put in communication with the strong pile, and there occurred a great deviation to the left, for example, indicating the letter C; the depression of the second button produced a contrary effect, and gave D; a depression of the third point-carrier gave a slight deviation to the left, indicating A; and a maneuver of the fourth button, producing the opposite effect, gave B. A maneuver of the first four buttons of the two other series of point-carriers gave, in the same way, I, L, M, and N for the second galvanometer and S, T, U, V for the third.

As for the twelve other buttons, they were designed to be employed in pairs. If, for example, the button of the fifth point-carrier in the first and second series was depressed, two strong deviations to the left were produced, and G was transmitted; and, in acting in the same way upon the last button of series 2 and 3, there occurred two feeble deviations to the right, thus giving the letter P.

As may be seen, such an effect might have been obtained by again making use of the first four point-carriers of each series, but it was doubtless in order to avoid all confusion that the inventor desired to have the buttons separate that were designed to be employed two by two.

Did Magrini's telegraph ever operate on a line of any extent? Upon this subject we lack information, but it is very certain that it would have been as capable of doing so as Wheatstone's five needle telegraph, and it is very curious to see that, at the same epoch, and entirely independent of one another, Wheatstone and Magrini brought out, although in different fashions, two practical apparatus, both based upon an indication, by the position of needles, of the letters marked beforehand on the receiver.

The same year, 1837, Masson, Professor of Physics at Caen, operated over a distance of 600 meters a two needle telegraph set in action by a Pixii machine.

A little later on, at the beginning of 1838, there was exhibited in Exeter Hall, at London, by Edward Davy, a needle telegraph in which the letters were painted upon a plate of ground glass. Screens carried by the needles prevented the light from a lamp located behind from reaching the letters, and each deviation of a needle to the right or left uncovered one letter or the other. The mercurial manipulator of this apparatus comprised 12 keys. As for the number of needles and line wires, that has never been clearly stated.

On the 12th of July, 1838, Amyot communicated to the Academie des Sciences a note in which may be read the following:

"After having studied the question as much as I have been able to, I have resumed it in the use of a single current, and of a single needle which writes of itself upon the paper, with mathematical precision, the correspondence that is transmitted to the other extremity by a simple wheel upon which one has written in his study by means of differently spaced points (like the wheels of our hand-organs), and which wheel revolves regularly by means of a watch-spring. In this way, one has only to write in a species of movable characters the news that he desires to transmit. This sort of dispatch is deposited in a box, and at the same instant it writes itself, unaided, to the distance whither one desires to send it. The agents who await it there have only to pick up the paper, which moves just as regularly by means of a

machine, and carry it to those who know how to read the cipher."

Amyot had this apparatus constructed at the request of Baron de Meyendorff, who sent it to St. Petersburg; but he in vain proposed to the administration of telegraphs that he should construct it for their use. Mr. Foy, who was then director of the telegraphic service, answered him that the invention was public property and that the administration would have the apparatus constructed themselves whenever they should judge proper.

Let us also mention among telegraphs of the kind that we have just passed in review an apparatus, the description of which was deposited by Messrs. Masson and Braguet under seal at the Academie, and which seems never to have seen light, and we shall have closed the series of needle telegraphs and reached the introduction of the electro-magnet in the construction of telegraph apparatus.—*La Lumière Electrique.*

THE MAGNETIC SEPARATOR.

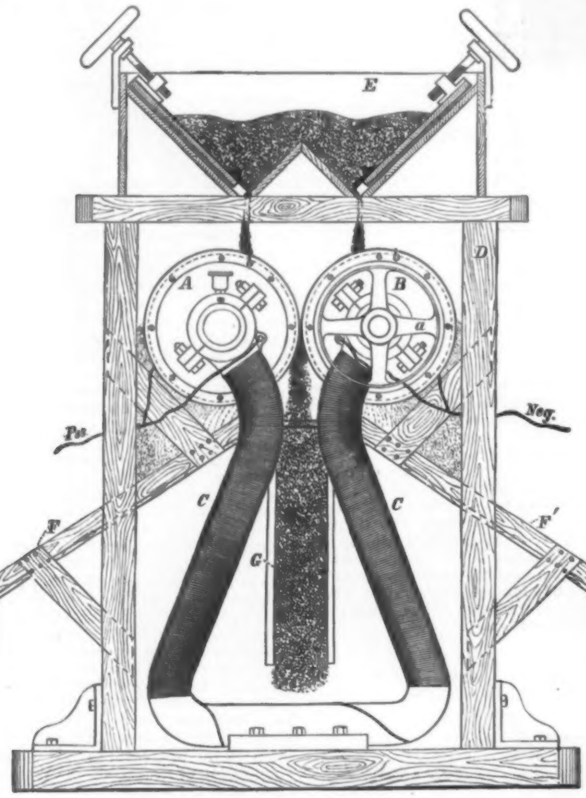
AMONG the many recent applications of electricity to the arts, one of the most interesting to those engaged in mining and metallurgy is that of concentrating ores. Though repeatedly attempted, particularly for magnetic iron ores, by the use of permanent magnets, it was not until the perfection of dynamo-electric machines permitted the economical generation of electric currents that any work worthy of serious attention was done. Naturally, the first field in which any effort was made was in the dressing of magnetic iron ores, and sands containing that ore, and in this direction the greatest progress has been made in this country. It may be of interest, however, here to recall the fact that, at a number of places abroad, magnetic separation has been extended to other classes of ores, notably close mixture of spathic iron ore, or iron pyrites and blende, previously roasted, as it is possible that by this method similar ores, now useless, may be made available here. The principal field of magnetic separation will, however, always remain the dressing of magnetic iron, sands, and ores. In the case of the former drying in a suitable revolving cylinder is resorted to, while with the latter class of material a system of crushing, pulverizing, and sizing is necessary. Mr. C. G. Buchanan, of this city, the inventor of the machine we are about to describe has shown us a sketch of a mill for this purpose, in which he has by suitable exhaust arrangements provided for the removal of the dust made during the crushing and screening, which would prove objectionable in the later separation. *The Engineering and Mining Journal* says: The principal market for fine magnetic ore, obtained by this system of dressing, is of course for forge fires and puddling furnace fix, the quantity which could be used in blast furnaces being limited by the inconvenience which raw material of such fineness would entail in the working of the furnace.

The Buchanan magnetic separator, which we illustrate this week, has been at work for upward of two years on sands, at Block Island, and possesses features of special interest. A and B represent the two cast-iron rolls, provided with heavy wrought iron shafts or journals. In section these rolls have an oval core, so that the surface of the rolls is uniformly magnetic. The distance between the surface of the two rolls is two inches. CC represent the iron standards supporting the rolls, and having journals in which they revolve. The rolls are provided with brass collars, *bb'*, intended to prevent the ore from dropping outside of them. D represents the wooden frame to which the stands are bolted and it also supports the hopper, E, and the chutes, F and G. The standards, C, are first insulated and then closely wound with heavy insulated copper wire, and the two ends of the wire are connected with the poles of a dynamo machine. It is evident that, if a strong current of electricity is passed through the wires, the standards, C, will become powerful electro-magnets, and that, if they are properly wound, each end of the same standard will be of opposite polarity, as indicated by the wires marked positive and negative. It is also evident that the rolls will be charged by induction, and that one roll will be of north polarity, and the other south. The peculiarity of this arrangement is, that a powerful magnetic field is formed between the rolls, and they are capable, while charged, of holding a weight of 500 lb. or 600 lb., if it is placed between them, while on their opposite side they are practically non-magnetic, and will not hold a tack.

The variations needed in dressing ores of different grades and sizes are controlled by regulating the power of the current of the dynamo-electric machine. The latter is of a special pattern, producing a current of a low electromotive force, the wire being heavier, and larger electro-magnets being chosen. It is built by the well known Weston Electric Light Company.

The operation of the machine is as follows: The rolls are rotated toward each other, at a circumference speed of 150 ft. per minute, and the hoppers opened so that the ore falls upon the top of the rolls. In passing over the rolls it is carried through the magnetic field, and all that is magnetic is attracted and attached to the faces of the two rolls, and carried around by them to a point where they lose their magnetic effect, and the ore falls into the chutes, F F. The rock being acted upon by gravity alone, falls directly into the chute, G, and a nearly perfect separation is thus effected.

The Union Foundry Company, of Rockaway, N. J., which builds these machines for Mr. C. G. Buchanan, the inventor, manufactures three sizes, the largest having rolls 24 inches in diameter and 36 inches long, with a capacity of treating 100 tons of ore per day, and larger quantities of sand. The range of sizes seems to be considerable. We are informed that ores as fine as from 40 to 60 mesh, and as coarse as from 8 to 10 mesh, have been treated successfully.



THE MAGNETIC SEPARATOR.

SIMPLIFIED TELEPHONE APPARATUS.

THE present progress in telephony belongs rather to the domain of practice than to that of science and theory; but it presents none the less for all those who are making daily use of the telephone an interest that justifies the short article that we desire to devote just now to the new simplified apparatus that are being supplied by the Societe Generale des Telephones.

These apparatus are more especially designed for private use in manufactories, hotels, etc. Fig. 1 represents one of them provided with a switchboard for six directions. It constitutes of itself a sort of central office that permits of communicating separately with each of the six lines that are connected with it, or of establishing a communication with any two of such lines. It goes without saying that there is nothing absolute about this number 6, as the number may vary according to needs and to the extension of the private telephone system that the central station does service for.

As well known, in all telephonic communications the person who calls must wait with the receiver to his ear for the information that he has been put in communication with the one whom he has called. Now, this is a tiresome position, especially when the subscribers to be connected do not belong to the same office, or when the person called is absent or momentarily occupied. The tiresomeness of waiting, joined to the fatigue attending the position, often makes the time appear much longer than it really is. The Lhoste elbow-rests, whose role and utility will be understood by a reference to Fig. 1, lessen such fatigue and allow the waiting to be done with more patience. Their height is regulated to the stature of the interlocutor by means of a curved ratchet and a click.

The simple apparatus is shown in Fig. 2, where a greater portion of the top of the desk is represented as removed, in order to exhibit the internal arrangement. The transmitter is always a 10-carbon Ader apparatus. The induction-bobbin and the automatic commutator are arranged beneath, in the body of the desk, and the call-button is placed in front, at the point where the lock of an ordinary desk would be situated. All the communications, then, are internal. The mounting of the apparatus is very simple, and, in fact, admits of but eight attachments—two for the line, at L, two for the local bell, at S, two for the local pile of the telephone, and two for the call-bell, placed beneath the desk.

The maneuvering and operation of this apparatus are absolutely the same as in one of the ordinary kind. When the telephone to the right is on its hook the apparatus is in a position of awaiting or calling, but, when it is taken off, the suspension lever rises and sets up a communication.

The receiving telephone is shown in section and elevation in Fig. 3. The principal and new part of this telephone is the magnet, the arrangement of which is shown in Fig. 4. This consists of a steel ring that carries two screw-threads, and two rectangular pieces of metal that constitute

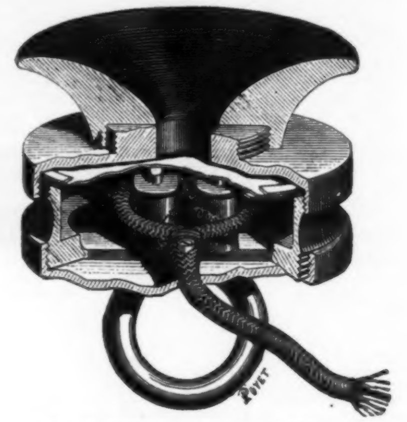


FIG. 3.—CIRCULAR MAGNET RECEIVER.

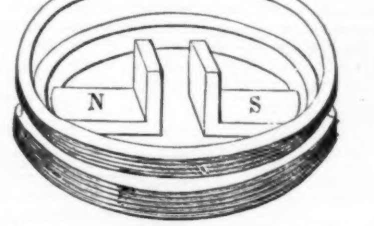


FIG. 4.—CIRCULAR MAGNET OF THE RECEIVER.

FIG. 1.—SIMPLIFIED TELEPHONE APPARATUS, PROVIDED WITH LHOSTE ELBOW-RESTS.

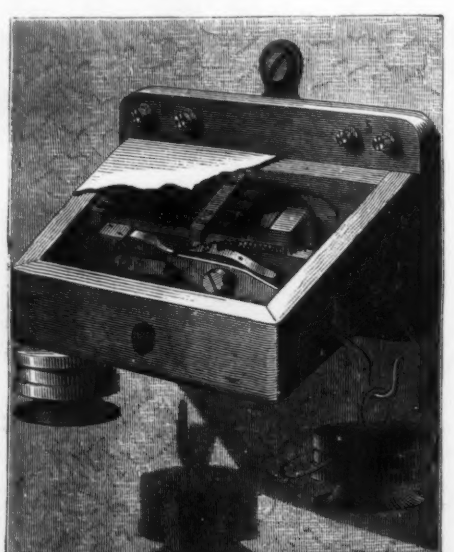


FIG. 2.—SIMPLIFIED TELEPHONE APPARATUS WITH CIRCULAR MAGNET RECEIVERS.

poles, to which are affixed two flat bobbins mounted in tension and connected with the line by means of a flexible cord. The two poles of this circular magnet are upon the same diameter, opposite the rectangular pieces of soft iron by which they are prolonged. Upon the lower thread there is fixed a cover that carries a ring which serves for suspending the telephone from its hook while the manipulator is waiting. The upper thread serves to hold the cover, the mouth-piece, and the vibrating plate. The distance of this latter from the poles is regulated by interposing between it and the cover a brass washer of proper thickness.

The telephone thus constructed constitutes a compact and rigid apparatus that cannot get out of order.—*La Nature.*

BACK PRESSURE IN DRAIN PIPES.

WITH properly-ventilated soil pipes and drains back-pressure cannot be caused by the expansion or compression of the air in the main sewers. It can only come from influences acting within the house itself, and affecting the atmospheric condition of the waste pipes inside of the main house trap. These influences are: first, the compression of the air in the main soil pipe by waste water passing through it; second, the pressure of the wind; and third, the suction of open fires and ventilating outlets throughout the house.

If a large body of water is thrown suddenly into the soil

FIG. 1.

pipes from one of the upper fixtures in a house, it drives the air in advance of it as it falls like a plug through the pipe. Were there no resistance to the passage of the air, such as is caused by friction, or by a sudden bend in the pipe, the air would pass through a properly ventilated pipe in front of the water without compression; but the rough interior of the soil and waste pipes, and sudden bends in their direction, causes considerable resistance to the escape of the air in advance of the water, causing condensation of the air, and giving rise to the so-called "back pressure" in traps, which is sometimes powerful enough to drive the water out of them in a sudden jet. The writer has completely emptied a four-inch pot trap having a seal four inches deep by this action, even though the soil pipe was properly vented at the top and bottom. A much lighter back pressure suffices to throw the water out of an ordinary S-trap. Fortunately, however, a very simple remedy exists for back pressure caused by falling water. The back pressure produced by the sides of the soil pipe, and by sudden bends therein, even when taken at a maximum (that is, when the water plug fills the pipe full-bore, and the test is made at the bottom of a long stack of pipes, and just above a bend of 90° in the direction of the water), never exceeds a few ounces to the square inch, and may easily be resisted by a column of water from 12 to 18 inches in height. Hence, a trap which is completely emptied by this back pressure when standing alone, as shown in the accompanying Fig. 1, as traps are usually tested in laboratory experiments, will easily resist the pressure when at-

FIG. 2.

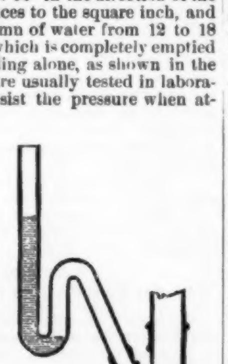


FIG. 3.

tached to and placed some little distance below a fixture, as shown in Fig. 2, or when the inlet arm is simply lengthened, as shown in Fig. 3. With a common S-trap the resistance to back pressure in Figures 2 and 3 is twice as great as in Fig. 1. The limit of resistance of an S-trap is the weight of a column of water twice as high as the depth of its seal. With a pot trap the power of resistance is much greater, since it contains water enough to rise under the influence of back pressure to a very considerable height in an inlet-pipe. Now, so far as the writer's tests have shown, the severest back pressure that can possibly be brought to bear upon a water trap in the plumbing of buildings having properly ventilated soil and drain pipes can be resisted by a column of water from 14 to 16 inches high. Hence, if a trap in such a building is placed under a fixture in such a manner that the bottom of its seal shall stand from 14 to 16 inches below the outlet of the fixture it serves, it may be considered perfectly safe against loss of its seal by back pressure. Moreover, it will be found that if the column of water in a trap is high enough to resist this back pressure, it will entirely exclude the entrance of the sewer gas or soil pipe air so compressed in the pipes. In other words, the air will not, under such circumstances, ever be driven *through the water column* in bubbles, as it is sometimes feared.

Hence, in setting traps under kitchen sinks where back pressure from water falling from fixtures above is to be feared, the traps should always be placed low enough below the outlet of the sink to permit of the formation of a water column high enough to resist the back pressure. Otherwise the water may be blown out of the trap into the sink and sewer gas will follow. The writer has heard of a case of diphtheria and death which was attributed solely to this cause.

With unventilated traps evaporation goes on with extreme slowness, and with traps containing a considerable body of water no danger from this cause need be anticipated, unless the building is left unoccupied and unwatched for years at a time. The effects of evaporation will be more fully considered hereafter. At present it is sufficient to say that in the construction of our trap care should be evidently taken to give it as large a water capacity as is possible, consistent with other requirements.—*Amer. Architect.*

WHAT SHALL BE DONE WITH THE SEWAGE?*

THE most important question that can engage the attention of sanitarians at the present day is—What shall be done with the sewage? If there is any truth in the germ theory—a theory which, it is safe to say, is the accepted doctrine of the most advanced investigators everywhere—most of the sewerage in vogue requires important modifications or abandonment; for it is quite certain that sewers, as now commonly constructed and appointed—of porous material, large size, with surface ventilation, subject to the retention of sewage in process of putrefaction, and depositing their contents at the margins of water courses which wash the shores of populous places—are better calculated to promote disease than to prevent it.

The absolute necessity of the prompt removal of sewage is no longer a question—all civilized communities recognize it. The innate abhorrence of matter so offensive to the senses is unquestionably based upon the danger of its presence—a natural recognition, shared even by many animals, which bury their excrements, or otherwise remove them out of their sight and smell. If Nature thus makes known her invisible laws by instinct, where reason cannot discern them, it is surely the unmistakable inference that the excreta of all carnivorous animals, those which practice the instinct of getting rid of it at least, and of human beings, should be speedily removed, if not, indeed, put into the ground, as the most effectual means of removal, and the most certain of all means of restoring to the earth that which has been taken from it for the support of nutrition.

We have no need, in this connection, to go into an elaborate discussion of the special fitness of the soil for the accomplishment of this purpose. It will suffice to state, briefly, the composition of human excreta, and the explicit conclusions based upon the fundamental laws of national economy.

Taking the results of a number of analyses sufficiently complete to give a fair average, the mean amount of human excrement per individual, during 24 hours, in ounces is 50·18—4·17 ounces fæces and 46·01 ounces urine. (In detail: of dry substances, 2·716 ounces; mineral matter, 0·643; carbon, 0·982; nitrogen, 0·531; phosphates, 0·257.)

In a mixed population, according to Dr. Parkes, the actual amounts voided are considerably less than this average, or not more than 2½ ounces of fæcal matter and 40 ounces of urine daily, for every individual; an estimate which gives 25 tons solid fæces and 91,250 gallons of urine for every 1,000 inhabitants. It is hardly necessary to state that of the composition as above given, nitrogen and the phosphates are the very things most needful for plants. To estimate the value of these substances, it has been calculated that the average amount of ammonia—representing the nitrogen in that form—discharged annually by one person, taking the average of both sexes and of all ages, is about 13 lb., and the money value of the total constituents of the excreta is, in urine, about $1.75; and in fæces about 40 cents, or one-sixth as much only as the urine—the total value being about $2 for every individual. Apropos to this estimate, Professor Thudichum remarks:

"1. The basis of human life, the very root of society, is the capacity to produce food in such quantities that a surplus of it may be exchanged for commodities resulting from the labors of other people unable to produce food.

"2. This capacity to produce food must be rendered permanent by a strict observance of the laws of nature regulating vegetable life, the knowledge of which is the basis of agricultural science.

"3. The first and most important of these laws is that we must return to the soil the mineral ingredients we have taken from it in gathering our crops. The atmosphere furnishes the nutritious elements, and the soil the minerals, out of which vegetable fibers, vessels, and structures containing food are built up. Without these mineral ingredients no harvest can properly flourish.

"4. These mineral ingredients are continually ejected from human beings and animals in their excrements; by returning which to the soil we furnish it with building materials for new crops, at the same time keeping pure the atmosphere we breathe and the water we drink, and thus preventing epidemics and (premature) death."†

But I would not divert attention from the main issue.

However essential agriculture may be to the welfare of man, as related to our present purpose it is of secondary importance. If, however, the safest, the most efficient, and most economical way of excreta disposal is also the most promotive of agriculture, as we believe it is, so much the better.

But the art of sanitation has not kept pace with science in this regard. Valuable as the constituents of excreta have been shown to be, the means of utilizing them are yet far from having been rendered thoroughly practicable. Considered in its most comprehensive aspect, sewage, as we have to deal with it, is polluted water. Reference is here made, of course, to the sewage of populous communities under the most universally preferred means of sewage disposal—water carriage. As thus presented, sewage consists of a specially offensive portion, excrementitious matter discharged from water closets, privies, and gully holes; kitchen slops, containing vegetable and animal washings and other refuse; soapsuds and dirt from the laundry; drainage from stables, barnyards, and slaughter houses; and ground surface washings and filth in various proportions. According to an average of the gross amount, based upon the most reliable English statistics, 100,000 gallons contain about 70 gallons, or one part in 1,300, of substances in solution; 40 gallons, or one part in 2,500, of suspended matter—a little more than one-half of this latter being mineral, and the remainder organic matter. Now, how to separate and utilize this one part of plant food in 100,000 parts of sewage, consistently with practical economy, we have not yet learned, and until we have, we must continue to bend our efforts wholly for the protection of the public health, by the disposal of sewage in all its forms as completely and expeditiously as possible, regardless of side issues and ulterior benefits.

Water carriage as at present practiced is divisible into two kinds—the combined and separate systems, both dependent upon the ultimate disposal of the sewage—whether directly into the sea, tidal water, inland river or lake, or to the soil; both systems being alike subject to modifications suitable to the circumstances, independent of, or in combination with means for separating the solid portion of the sewage from the liquid.

The *Combined* system consists of a single line of street sewers sufficiently large to receive all storm water, provided for by basins at the street corners, all waste water and drainage from manufactories, stables, abattoirs, etc., together with the house sewage and the roof and yard waters. Hence, the mains in large cities are frequently great tunnels from six to fifteen feet in diameter. Being commonly constructed of brick or other porous material, their walls are saturated with filth in constant process of putrefaction, and incessantly giving off foul emanations.

With capacity adapted to the amount of rainfall in the heaviest storms, they are flushed only at such times, when they run nearly full. Other times, and especially in time of drought, they contain comparatively little sewage, but are full of gas constantly seeking the easiest means of escape, whether in or outside our houses; and on the setting in of a storm, by the pressure of water, the ordinary traps to house fixtures are a well nigh useless appendage. Ostensibly to prevent the escape of sewer gas under such circumstances, many contrivances have been adopted for deodorization and ventilation, but in view of the now generally accepted theory of the germ origin of disease, and that sewer air is a prolific source of disease germs, such sewers are deservedly looked upon as dangerous to the public health. They should be discarded—wholly converted to the purpose to which they are only suited, storm water conduits, but with such additions as will also drain and cleanse the soil. Thus converted, they would constitute the first part of

The *Separate* system. This consists of two parts; first, that which has already been indicated, to drain the soil and carry off all surface waste and storm-waters; and second, a small, non-absorbent, and impervious pipe system of only sufficient caliber to carry excreta and house-water, and without surface ventilation or other opening (except for light and hand-holes in case of obstruction)—ventilation being accomplished by the open ends, of full caliber, of every house-drain connection extending above the roof. Flushing is provided for in this system by means of siphon flush-tanks at such intervals and distances as to effectually prevent the retention of any sewage long enough for putrefaction to take place.

In cities of 50,000 population or less, with favorable surface—as in the case of Memphis—this, the *second part* only of the separate system, may be laid in conjunction with surface drainage.

But in cities of larger population the separate system comprehends a separate line of pipe of sufficient caliber, with subsoil yard branches and street gutter connections at such intervals as may be required to carry off all subsoil, storm and surface-waste water from all sources.

A modification of, or rather improvement upon the separate system, as hitherto practiced, has recently been invented under the name of the—

"*West*" system—that which is now constructing at Atlantic City and Coney Island. It is essentially a small pipe system, adapted to the carriage of excreta and house-water exclusively. It begins with a large well sunk to a proper depth, according to the estimated amount of sewage to be dealt with. This well is made thoroughly impervious to both air and water. From near the bottom of the well the main sewer ascends toward the surface with a gradient of not less than ten feet to the mile. With this main all necessary laterals and branches with co-ordinate gradient unite. All corners or turns are made with a bend and a Y, so that there is no chance for any excrement to lodge, but to run smoothly to the well. The diameter of the pipes runs from six-inch, which is used for connections, to twenty-four inch, which is used for the main sewers. The pipes being small, at all times nearly full, and having sufficient incline, the sewage runs with great rapidity, carrying everything before it; and being at once pumped from the well before putrefaction sets in, there can be no sewer gas. Besides, all house connections are continued to the top of the house and a few feet above, as a means of ventilation, and to keep all smell from the house.

In the well one or two powerful pumps are placed, of sufficient capacity to raise and force 1,000 or 2,000 gallons of sewage per minute upon filtering beds located at places devoid of possible nuisance. Here the liquid sewage is at once filtered through a mass of deodorizing and antiseptic material, and discharged into the sea or a water-course; or, if this delivery be objectionable or unavailable—as in inland towns—the filtered liquid is utilized for agricultural purposes, by irrigation; meanwhile the suspended matters are simultaneously converted into "bromo guano," and made merchantable to farmers.

While this system has special advantages for small towns, where storm-waters can be taken care of on the surface, it is also adaptable, by multiplication of centers of operation, to even the largest cities, in conjunction with a storm-water system, or to those cities which have dangerous systems fit for storm-water only, and to which they should be diverted; and to outlying districts of cities already sewered, not easily accessible by other means, except at great cost.

Moreover, in cities only partially sewered, or where more expensive and less efficient sewerage has been undertaken and suspended, sewers already laid—with a gradient of not less than ten feet to the mile—may be utilized in the adoption of this system in the interest of public health, efficiency, speedy completion, and economy.

Shone's *Pneumatic* system, by means of *sewage ejectors* operated by engine-power to force the sewage through pipes over rising ground, has found favorable application in some English cities. It is more economical than deep cuts, and applicable as a remedy in overcoming the sluggish flow in sewers with insufficient gradient. For operation on a large scale, it contemplates the discharge of the sewage by gravitation into large collection stations, similar to the wells in the West system, according to the size and contour of the town. Into these the *ejectors* are placed, and the sewage forced to the outlet. This system evidently possesses some advantages, but as compared with the West system it is more complicated, more costly, and less complete.

* Read before the Maryland Sanitary Convention, November 28, 1883, by A. N. Bell, and published by permission of Maryland State Board of Health, from advance sheets of forthcoming Annual Report.—*The Sanitarian.*

† "Grundlagen der öffentlichen Gesundheitspflege in Stadten." Frankfurt, 1865.

The Lieurner *Pneumatic* system is a still more complicated method, which has met with favor in a few Dutch cities. It comprehends air-tight iron tanks under the streets, connected by means of iron pipes with water closets of special construction, and is operated by a powerful steam-power air pump. It pretends to deal with excreta *only*—a limitation which virtually excludes it from general adoption or favorable consideration. It fulfills no condition which cannot be more economically and effectually conducted by other means sufficiently described.*

Of the rest—the various pail, bucket, and earth systems, for small towns—little need be said. They are greatly inferior to the "West" system, for manifest reasons. They make no provision for the disposal of kitchen-sink and other waste waters of the household, scarcely less dangerous than excreta, and of which the amount is rarely less than twenty gallons daily for every household. The dry earth system, to take care of fæces and urine alone, requires at least four pounds of dry earth or ashes daily for every individual—an amount which renders the system burdensome even for schools and public institutions, and for towns wholly impracticable. Besides, all these makeshifts are based upon the dangerous principle that excrementitious matters may be retained about the premises, provided they are deodorized, subject to convenience for removal—based upon the fallacy that deodorization and disinfection mean the same thing. That dry earth deodorizes excrementitious matter is common knowledge, but there is no evidence whatever that it disinfects it. On the contrary, it is well known that earth thus surcharged, on becoming moist is offensive in consequence of the putrefaction which is then set up, leaving the inference pretty clear that, even when dry, material which it has deprived of odor may be, notwithstanding, in the highest degree infectious. Indeed, some of the most malignant of infectious diseases, cholera, for example, are spread with the greatest facility when the material holding the seeds or germs is in a perfectly dry state. This is probably equally true with regard to typhoid fever and diphtheria.

Safety in the use of the dry earth system essentially consists in the same practice as the "West" system—the prompt disposal of the material (the earth) which retains the excreta, before putrefaction takes place. Distributed in the soil the gaseous emanations and soluble parts suitable for plant food are thus effectually disposed of, and the residue returned to its original elements by the process of oxidation. The cardinal doctrine of all systems should be

Ultimate removal before putrefaction—this is the danger signal, but, unfortunately, not always easily discernible; consequently, any system which fosters it requires the utmost degree of watchfulness.

Of the various means adopted for the storage of excreta, or for its removal from one place to another out of sight and smell, from time to time, to enumerate them is to condemn them. Everybody knows the danger of food and drink poisoned with excrementitious matter. Loaded cesspools and privy vaults, as ordinarily constructed, in proximity to wells, springs, and dairies, are a perpetual source of such danger; and to such an extent as to leave no room for doubt that not less than 100,000 persons are killed annually in the United States by filth poisoning thus propagated. The only tolerable cesspool system is that which may be used in connection with subsoil distribution through open-jointed drain tiles. As thus adapted, with impervious walls, and both cesspools and drains sufficiently distant from the domicile and water supply, cesspools may be used with a minimum of danger. In reply to the question likely to arise, At what distance from a well would it be safe to place a privy vault or cesspool?—The greater the better; but ordinary soils have a lateral drainage area equal to five feet for every one foot of depth—that is to say, a well twenty feet deep is ordinarily the receptacle of any soluble matter in the soil water for a distance of one hundred feet in all directions. Under some circumstances—such as subsoil currents in certain directions—the danger distance is much greater.

Of privy vaults, if they *must* be used, it will suffice to say the walls should be made impervious, and disinfectants so freely used as to prevent putrefaction during the intervals—which should never be long—between removals of contents and excavators used for emptying them. To render the walls of cesspools and vaults impervious, the inner courses of brick should be laid up with tongs—each brick being dipped in a boiling hot mixture of coal tar and asphalt. But for the single domicile, a better way is not to have a vault, but a tight box or pail, to use dry earth or ashes as a deodorant, and the same care in regard to prompt removal as required for the earth closet.

FACE PAINTING.—THE ACTOR'S ART.

"GIVEN a clean shaven face, the features of which are not specially prominent, and it is comparatively easy for an artist in make up to transform it into a fair likeness of any type of character he wishes to represent, or even to imitate a particular individual. The face in his hands becomes almost as plastic as the clay under the touch of the sculptor. Of course the actor cannot remould his features, but by putting on different colored paints he can present an effect which, viewed from a little distance, has all the appearance of having been remoulded. The great secret underlying all the triumphs of this art is that white brings into prominence and black depresses. For instance, take a nose that is reasonably straight. Suppose it is desired to make it a pug. Put a little dark brown on the bridge and make the end lighter than all the rest of the face. The gradations have to be nicely shaded, and there comes in the art. To reverse the process, and produce a marked aquiline, hook, or Jewish nose, put white on the bridge and darken down the tip a little. That will bring forth an aristocratic nose that would do credit to any duke in the British peerage." Thus spoke a comedian skilled in the mysteries of the stage dressing room.

"But are not false noses sometimes put on?"

"Very seldom nowadays on the legitimate stage, except for some very markedly eccentric comedy part, and even then they are much more artistically constructed than of old. Formerly they were made of cardboard, and the joining line could always be seen. Lately a kind of putty has been invented which will adhere tightly to the skin, and can be moulded into any shape desired. The edges of the false nose can be worked down as fine as a sheet of paper, and when painted over to match the face the joining is practically invisible. Bibulous Bardolphian noses are made in this way, and I believe *Sam'l of Posen* is now constructing his trade mark of this putty. It may also be used for chins, cheek bones, and bulging foreheads. Before this putty was obtainable, actors who needed extra fat faces used to glue on thin layers of cotton wool and put powder and rouge over them. Things are very different now from what they were when an actor's make up consisted of some drop chalk, a powder rag with which to put the chalk on, a little dry rouge, a hare's foot for applying the same, and a piece of cork which he would burn and use for making wrinkles, eyebrows, and sometimes even mustaches. The introduction and general adoption of grease paints have, however, changed all that; and if we can't act as well as they used to—which I don't believe, though I hear it every day—we look a great deal better. Fancy Garrick playing Macbeth in a British general's uniform, and wearing a 'queer' court wig! Why, it must have been funnier than the Count Joannes in Hamlet.

"But to come back to the grease paints. There are colors mixed with a hard grease, a little of which is rubbed on the face and then smoothly spread over with the finger. One of its most valuable properties is that it is not affected by perspiration, and requires grease or soap and water to remove it. Generally the actor rubs a little vaseline or cold cream over his face and wipes this off with a rag before washing, thus removing most of the paint and getting the soap to lather more easily."

"Does not this constant painting of the face injure the skin?"

"It does not appear to when it is properly washed off at night, but persons who are careless may let it block up the pores of the skin or remain in the roots of the hair or eyebrows. The number of shades in which grease paint is now made is very great, and every actor who takes pride in his make up will have from a dozen to twenty kinds. Even in flesh tint alone there are six varieties, from the very delicate creamy white of youth to the leaden sallowness of extreme old age. Besides these there are shades for Chinamen, and for every gradation of Indian and negro blood. Then there are whites for 'high lights' and for whitening mustaches or eyebrows, browns for shading, blues for veins and hollows, reds, blacks, and yellows. You mustn't think they are all used in one make up, though often seven or eight colors are combined in an elaborate one. The first thing to do in making up is to select the proper flesh tint. This having been chosen and applied, the next thing is generally the rouge. Except in the case of very old characters, some red must be put on the faces, or the yellow glare of the footlights will make them look perfectly ghastly. But where the red is to be put and how much of it and what shade to use, depend entirely upon the age of the person to be represented. The younger the person the more delicate the tint of rouge should be and the higher it should be upon the face. Thus, for a very young man, the rouge is put on in a half moon shape, one horn beginning at the inner corner of the eye and the other extending well up the temple as high as the eyebrow. As the age increases we cease to run the color up so high on the outer side, until for mature years it settles down into the hollow below the cheek bone."

"The rouge being properly applied, we next go to work upon the wrinkles or hollows. In representing age the principal lines to be emphasized are those from the nose to the corners of the mouth, from the corners of the mouth to the chin, from the inner corners of the eyes to the hollows of the cheeks, and those on the forehead. Some actors make the wrinkles in blue, others in brown, and others in gray. It is a matter of taste. The lines are made with thin sticks of the paint cut to a point, or with a pointed leather stub upon which the paint has been rubbed. After the wrinkles have been put on it may be necessary to accentuate them by a line of white or light color on the edges, and these lines must be graduated into each other so as not to seem too hard or abrupt. In representing old men the strong muscle above the line from the nose to the mouth must be brought out very strongly with white. The cheek bones under the eyes must be treated in the same way. Then the eyelids require darkening for age, and crows' feet are carefully drawn with a number of thin irregular lines at the outer corners of the eyes. Where youth is shown, the upper eyelids and skin under the eyebrow are delicately rouged. If hollows in the cheeks, temples, or neck are wanted, these are the next things to be done, and the outlines of the cheeks may be rounded out with light shades or made to assume eccentric shapes with darker ones. The muscles of the neck may need bringing out, and hollows put under each side of the chin. Lips require rouging for youth, and bluing or darkening for age. Large mouths are made small by putting rouge only in the center of the lips, and small ones made large by rouging all the way, and even extending the corners with a line of red. Where toothlessness is desirable the teeth are covered with a thin coating of black wax, which renders them quite invisible. This process is technically called 'stopping out.' The face being now colored, rouged, lined, wrinkled, and hollowed, the next things to be attended to are the eyebrows, and hair or beard if any are required.

"Very few people are aware how important a part the eyebrows play in forming the expression of the face. Bringing them very close together will cause a look of meanness or villainy; a high arch will insure surprise or vacancy of expression. A slight upward turn of the inner corner makes some faces very handsome. Eyebrows are often painted; but if very heavy ones are needed they are stuck on over the true ones. If the actor is going to wear his own eyebrows or mustache, he colors them to match his wig with grease paint, which, after being rubbed on, is combed so that each hair is colored and there is no matted appearance. The use of mustaches and beards made on wire and hung from the ears has almost entirely gone out except among supers and utility people, as, being independent of the skin of the face, they did not move with it, and consequently never appeared natural. The best mustaches and beards are now made upon a thin foundation of silk, each hair being drawn through separately and knotted. The foundation is fastened to the face with spirit gum, another modern invention of great value to actors. It consists of gum dissolved in collodion and alcohol. This mixture dries immediately it is exposed to the air, is impervious to moisture, and can only be removed by spirits or grease. When the actor had to depend upon plain glue or gum, he was always in fear of losing his false beard, and many are the funny stories told of swallowing mustaches or transferring them to the faces of ladies who have had to be embraced in the course of the action of the piece.

"Many actors prefer to make their own beards or whiskers nightly, as they do not like the feeling of the solid foundation on the skin, and, indeed, an all round beard is apt to restrict the easy working of the jaws. Whiskers or beards are made from wool or crape hair, both of which can be obtained of any desired shade of the theatrical wig makers. The hair or wool is drawn through a coarse comb to a little longer than the length desired. It is then cut close to the teeth on the under or more solid side. An even mass is thus obtained which is readily fixed to the gummed cheek. The real art is in the subsequent trimming, with very sharp scissors, to the shape desired. Wool is more easily handled, but hair which comes in short lengths, plaited, is the most realistic. It is this that detectives use for disguises, and when well put on it is almost impossible to detect its falsity, as each hair seems to grow out of the skin.

"Almost the last stage is the putting on of the wig. If this is not a bald one, the hair is brought down so that the junction with the forehead is not seen. Many foreign actors prefer to have their wigs made with a forehead piece, painted to match the face. Bald wigs are, of course, made in this way, and the edges are hidden with a thick dressing of grease paint, or, as it is sometimes called, joining paste. This being done, a coat of powder of the proper color is delicately dusted on the face. Powder is prepared in every shade from white to orange. It has the effect of deadening the shininess of the grease paint, of softening the lines and blending the work into one harmonious whole.

"An actor is often nearly an hour on his face. Mansfield, in the 'Parisian Romance,' took fully that length of time, but he had a very young face which had to be transformed into a very peculiar and prematurely wrinkled one. He put six or seven shades on his forehead alone. He was careful, too, to make up his hands, a thing which many a good actor forgets. Yet how absurd it is to see an old, wrinkled face accompanied by young, plump hands. For an old man the knuckles should be whitened, the hollows between them darkened, and the veins marked with white blue."

"Do actresses make up in the same way?"

"No. They very seldom use grease paint, and, in fact, it is not necessary for them, as they rarely consent to line their faces. In this country it is very difficult to get a young woman to represent an old one; and when she does she puts on a gray wig and leaves her face young beneath it. Abroad it is different. They think more of their art and less of their appearance. Actresses generally use a liquid white, which has some mineral basis, and is in the end hurtful. The safest compound is a preparation of oxide of zinc, rose water, and a few drops of glycerine. A little rouge, the darkening of the eyebrows, and a touch of red on the lips complete a lady's make up. Most of them line below and above the eyelashes with black, which gives brilliancy to the eyes. They are very apt to overdo this, and then their eyes look like burnt holes in a blanket. You must have often noticed this, especially among the members of the ballet, who daub their colors on with the greatest liberality. As a rule, we are far ahead of the European actors in the art of making up. Any one who noticed the male members of the Bernhardt company must have remarked how coarsely and crudely they were painted. Our actors are better paid, and can afford to buy better materials. Take wigs for an example, which are among the most important aids to a make up. An English actor will not give more than four or five dollars for a wig, where I would buy one valued at twelve or sixteen dollars. We have some of the best wig makers in the world here in New York, but it is only within the last few years that they have become alive to the fact that the less hair they put in a wig the better. All that is needed is just enough to cover the net foundation. The old wigs used to bulge out from the head in the most ridiculous way. Now a straight haired wig will fit quite close to the head. But, as in the whiskers I spoke of, each hair is fastened individually. Montague paid forty dollars for a short haired fair wig he wore in 'False Shame.' Some actors and actresses hire their wigs for pieces that are only expected to run a short time, and several theatrical wig makers have very extensive stocks for this purpose. Character actors, however, nearly always have their wigs made to order according to some particular fancy, and it is no unusual thing for an actor to own three or four dozen wigs.

"One last word about make up. It is very singular that no matter how old an actor grows, he generally thinks that if he has to portray an aged man it is necessary to line his face. We have a true story in the profession of a veteran actor who had grown almost too infirm for work, and had been given the place of prompter in a city theater. One night one of the actors was taken ill, and in the emergency the part was given to the prompter. The character was supposed to be that of a little man fifty years old, and the prompter owned to sixty-eight. But at night he was found in his room drawing lines over his face till it looked like a railroad map.

"'What on earth are you doing there, Jack?' asked the actor who shared his room.

"'Doing!' responded the veteran, as he corked in a couple of heavier lines, 'Why, making up for this darned old fossil.'"—*N. Y. Sun.*

THE EOCENE FAUNA OF SOUTHERN PATAGONIA.

WE have been accustomed to regard the Tertiary lands of the Western Territories as the pre-eminent depositories of that wonderful mammalian and avian life which Marsh, Cope, and Leidy have helped to explain and exhibit; but we are now likely to have our eyes drawn in an opposite direction to the rich faunal remains of Patagonia, which bid fair to rival in importance the relics of their northern and contemporaneous brethren.

South America, as is well known, is the home of the edentates, which are yet numerous there, and which, toward the end of Tertiary times, attained a wonderful development, when the *megatherium*, *mylodon*, *megalonix*, and *glyptodon* reached the colossal dimensions of the great ungulates of the northern hemisphere. Until recently, we knew nothing of the faunas which preceded this; but new researches elicit the fact that the tertiary strata are probably all represented in South America, notably in Patagonia, and we shall find here forms of the greatest importance in the palæontological scheme of animal evolution.

In 1876 M. Francisco P. Moreno, director of the Archæological Museum of Buenos Ayres, undertook an expedition to this desolate region, whose forbidding shores and uninhabited wastes had repelled other distinguished naturalists and prevented any extended search over their vast extent. M. Moreno ascended the river Santa Cruz in a boat drawn by horses, and after a dangerous and obstinate struggle with many obstacles, in twenty-five days reached the point at which Darwin had abandoned further exploration. Five days afterward he discovered a lake, to which he gave the name of Argentine, which was fed by the melting glaciers which had moved down the slope of the Andes, and which in turn emptied itself into the channel of the Santa Cruz.

The lower part of the river was desperately arid—sand, pebbles, and clay furnished a soil upon which a stunted vegetation barely supported itself, and which offered insufficient food for the animals. Guanacos, some rodents, and the South American ostrich formed the only game. Higher up, the land assumed the wild and castellated aspect of the

* For description of this system in detail—illustrated—see *The Sanitarian*, vol. vii., p. 296 *et seq.*

Bad Lands of the West, and here as there great deposits of mingled bones furnished the index to the character of its past inhabitants.

Fire and flood have successively desolated this country, and the Tertiary strata are in some places buried underneath lava outflows which have destroyed the palm forests that before the elevation of the country waved over this land. Great glaciers at present move down the elevated declivities of the Andes, and the travelers saw them issue upon the broad lakes, and form, as they broke apart with loud detonations, mimic icebergs, while far above them shone the strange light of volcanoes, and floated their lines of smoke like a pale and fantastic shroud.

Half way between the mouth of the Santa Cruz and the Andes is found the ossuary, which will render M. Moreno's expedition famous. Here the Tertiary strata, according to the discoverer's account, are tilted up so as to be almost vertical, whereas Darwin remarked in this region upon the horizontality of the strata. Here, under the glacial drift, were detected many lacustrine and marine beds which alternate, indicating successive immersions and emergencies. The Eocene, Miocene, and the Lower Pliocene are represented here, as in North America, by mammalian types, very distinct, corresponding to the marsupials, pachyderms, edentates, rodents, and living carnivores, or at least to forms which preceded them in the geological sequence.

Among these M. Moreno has described a skull under the name of the *Mesembriotherium Brocae*, which appears to be a generalized type, and which deranges our modern classifications by a mixture of characters which are now only found represented in very distinct animals, but which in this ancient type appear united. It presents marsupial characters in the form of its single molar, while the skull allies it to the terrestrial carnivores and to the seals, which suggests the thought that it was a transitional marsupial form which probably enjoyed an aquatic existence.

The ungulates, so numerous in North America, are sparsely represented as yet in South America, although M. Lista has found at the source of the river Chico a skull which M. Burmeister places under the genus *Anchitherium*, and which resembles its congener of the United States, being also a Pliocene form. Again, from the Tertiary of the river Gallejos the remains of an ungulate have been found allied to the North American *Hyracodon*, but lower and antecedent. In the same deposits of the river Gallejos, but higher up, probably Miocene *nesodonts* have been found, ungulates which are common in the Patagonian fossils. The toxodonts, which seem to unite the ungulates with the rodents, are found in Patagonia, and the skulls of two other genera of small animals, which seem to form a transition between the rodents and the toxodonts; and, again, true rodents are found in this deposit.

In fact, this fossil fauna abounds in transition forms. Among the most remarkable is a skull the shape of whose molars is such that it can be only assigned to a gigantic capybara or a dwarf elephant, between whom at present there exists a profound gulf. The edentates, which bestow so unique a character upon the pampas fauna, have been found as yet only in the upper strata, the so-called Quatenary, of South America. The real center of dispersion for the glyptodonts seems to have been the southern region, and M. Moreno has found a diminutive species of armadillo yet living upon the banks of the Santa Cruz. Doctor Cunningham first announced the discovery of these animals in the Tertiary, and remains have been produced by M. Moreno from the upper layers of the Santa Cruz beds. Marine mammals are also represented here, and fossil debris indicate a new genus of whales, and dolphins, seals, and birds.

It appears from these facts that the Patagonian Tertiary fauna preceded that of the Argentine Republic, and held many of the links of the mammalian pedigree. The French expedition which started from Cape Horn in September, 1882, was destined to explore Tierra del Fuego, and their researches may throw some light upon the Patagonian finds, inasmuch as the islands which terminate South America belong to the same geological formation. And if, as has been advanced by M. Moreno, there existed at this point a vast continent in Tertiary times, Tierra del Fuego would have formed its center, and its geological beds ought to contain the relics of that same fauna which is found in the valley of Santa Cruz.

These investigations throw a new light upon the interesting history of the geology of South America. Hitherto it had been supposed, upon the statements of D'Orbigny, Darwin, and Burmeister, that all of Patagonia was a recent Tertiary marine deposit. Now, it is shown that there are large lacustrine or fresh water deposits. The presence, furthermore, of a rich fauna lends weight to the opinion that at the opening of the Tertiary a great continent extended to the east and west, encroaching upon the actual beds of the Atlantic and Pacific oceans. And this fauna has not come, as has been supposed, from the north, but has spread from the south northward, when the glacial colds were first felt in Patagonia. Traces of emergences and submergences are numerous, and remains of a luxuriant vegetation indicate a climate much warmer than that at present found there. To-day the southern portions of South America undergo slight oscillations, and the seaboard of Patagonia is slowly sinking, while those of Chili are as gradually rising. The soundings in the Atlantic show that the eastern margin of the continent is continued out into the sea by a slope which forms a vast submarine plateau, from which rise the islands of Falkland and Tierra del Fuego. An elevation of at least 150 meters would reunite these islands to the continent; another elevation of 2,000 meters would embrace the Falklands to South Georgia and the Sandwich Islands and the Antarctic zone. The direction of this submarine plateau, which doubtless represents the principal crest of the submerged continent, seems indicated by the sort of hook toward the east which Tierra del Fuego and Staten Island now form in that direction.

Hence we are told that toward the middle of the Tertiary period, before the elevation of the Andes, the two Americas were not yet united by the Isthmus of Panama. Brazil formed a great island with its present contours, while the sea invaded the valleys of the Plata and Amazon. Bolivia and Patagonia formed an immense peninsula bordered by great gulfs east and west. The sea of the Antilles joined the two oceans, and the equatorial current flowing between the two Americas helped to confer upon the Antarctic continent an intertropical climate. The numerous groups of islands in the Pacific Ocean appear to be the remains of the submerged continent which united Australia and South America. According to Hooker, there are not less than seventy-seven species of plants common to New Zealand, Tasmania, and South America. These plants form the remnants of a flora once diffused over these amalgamated divisions. Darwin has also remarked that the existing faunas of Australia and South America present the same characters as those which have immediately preceded them; another point of resemblance.

The breaking up of this continent began probably toward the end of the secondary period, when Australia separated, though South America remained united to the Antarctic regions. The marsupials developed separately in each half, and with the Miocene the edentates appeared in Patagonia with no satisfactory indication of their origin. Then followed volcanic outbreaks, succeeded by the southern ice age, and the movement northward and then southward, after the close of the period of great cold, of the descendants of the Tertiary mammals.

This is not the first time that the conception of a great southern continent has entered the minds of naturalists and geologists. Hooker, Wallace, E. Blanchard, and A. Milne-Edwards, after having studied in the eastern hemisphere the fauna and flora of New Zealand, of Australia, of the Indian Archipelago, of Madagascar, and the Mascarene Islands, reached the same conclusion as M. Moreno.

Although it is now assumed that the present beds of the oceans and the present continental masses maintain relatively the relations presented by them in the first ages of geological time, yet it is not insisted upon that modifications and even important changes in the disposition, shape, and position of oceans and continents may not have ensued, and this hypothesis of an Antarctic and Oriental continent is not supposed to radically controvert this general axiom.—*Trouessart*, in *Revue Scientifique.*

STATICE SUWOROWII.

WE are indebted to Messrs. Haage & Schmidt for the

STATICE SUWOROWII.

receipt of fine specimens, native and cultivated, of this newly described species. The original figure in the *Gartenflora* gives no idea of the beauty of this fine species as grown by Messrs. Haage & Schmidt. It is in the way of S. spicata, but larger in all its parts, the flowers of a deeper color, and the glaucous undulated leaves are broader and less deeply divided. The small illustration above we now give—and for which we are also indebted to Messrs. Haage & Schmidt—shows on a greatly reduced scale the general habit of the plant, while the botanical details given in the *Gartenflora* relieve us of the necessity of repeating them here. For garden purposes Statice Suworowii may be described as a very fine growing, profusely flowering annual. A single plant will, as exemplified by the specimens sent to us, last in bloom for more than two months. If sown in succession from February to April, it may be had in full bloom throughout the summer from May till October. A bed of this plant is a beautiful sight, being one mass of pale rosy-lilac flower spikes, which conceal the comparatively small foliage, which lies on the ground. Regel's figure shows an unbranched spike, but in cultivation a central spike, some 15 to 18 inches high, is produced with ten to fifteen side spikes, the whole forming a pyramidal mass. We have here doubtless one of the finest annuals for summer gardening or for greenhouse purposes, and one for which we may safely forecast great popularity if our gardeners manage it as well as Messrs. Haage & Schmidt have done. The plant is a native of Western Turkestan, where it was discovered by M. Albert Regel.—*Gardeners' Chronicle.*

THE MOUNTAIN TOBACCO.

Arnica montana.

VERY few seem to know this pretty composite from the mountains of Central Europe, yet it is a most desirable plant in many ways; it flowers freely and is very showy in early summer; The annexed woodcut represents its habit of growth admirably. The flower-heads are large compared with the other parts of the plant, being some 3 inches or more across. The florets are of a bright orange, an effective color among early summer flowers. I grow it admirably in the most exposed part of my rock garden, and find that it does best in a good loamy soil, rather stiff than otherwise. Planted well at the outset it gives no further trouble. During the last few years I have grown it better than formerly, and I get a better crop of flowers. It is a plant which I should like to see more generally cultivated than it

ARNICA MONTANA.

is. The roots yield an acrid principle called arnicine.—*J. W., in The Garden.*

A NEW PLANT.

(*Caraguata sanguinea.*)

THE first specimens of this new Bromeliad were collected by me in May, 1876, in the western Cordilleras of the Andes of New Granada, between Tuquerres and Barbacoas, at a place called Los Astrojos. It grows here and there as an epiphyte upon certain large trees, which it ornaments with its beautiful blood-red foliage. Its colors are so brilliant that the Cargueros Indians, who traverse the route called the "Terrible Road," often gather living specimens for planting, in the way of a votive offering, upon a cross formed of two pieces of tree-fern (*Alsophila*), and called for that reason *Cruz de los bicundos* * I gathered quite a large number of specimens, which were sent on at the same time as the first ones of *Anthurium Andreanum*, when I discovered that beautiful Aroid; but the Bromeliad perished in its packing before reaching Europe.

In 1880, in a new exploration, organized with the aid of a few amateurs of Southern France, I succeeded in introducing good seeds of *Caraguata sanguinea*, and from these were produced the plants upon which is based the description that we publish.

Description.—Plant of middling size, scarcely exceeding 40 to 50 centimeters in diameter by from 30 to 40 in height, with a closely rosulate and slightly flattened head. Leaves

* *Bicundo* or *Vicundo* is the name given the Bromeliads in this part of New Granada, and the species under consideration is called *Bicundo Colorado.*

A NEW BROMELIAD. (*Caraguata Sanguinea.*)

numerous, erect, then widely spreading, recurved, from 20 to 30 centimeters in length, flattened, edges incurved, long-sheathing, slightly dilated at the base, edges subparallel, apex acuminate, revolute, and undulate, point sharp-canaliculate, surface finely grooved, color of a delicate green, tinged with red when young, gradually becoming spotted with a red violet at first that passes to blood-red and becomes more and more colored as the moment of flowering approaches, and varying in coloration (according to the individual) to such a degree that certain ones are entirely purple, while others were more or less spotted. Inflorescence terminal, nidulant (a character up to the present unique in the genus *Caraguata*), forming a close spike, subsessile, surrounded with closely imbricated, oval bracts, between which are developed shortly pedicollate flowers of a straw-yellow variegated with white. Calyx gamosepalous, with a base a quarter of its height, with three thick lobes, obtuse-cucullate, long, and of a hyaline white. Corolla gamosepalous, 5 to 6 centimeters in length, tube cylindrical, slightly swollen at the apex, lobes spreading, oval, obtuse, slightly concave; stamens adnate to the tube of the corolla up to the orifice of the throat, subunited into a conical glomerule, anthers sagittate, yellow; style filiform, exserted, white, stigma green, with three straight papillose branches; ovary with three rounded angles, and three cells bearing numerous ovules; capsule cartilaginous, brown, cylindrical, seeds silky as in all the Tillandsiaceæ.

The *Caraguata sanguinea*, which was exhibited for the first time at the 11th of January (1883) session of the National Society of Horticulture of France, received there a first-class premium. It was one of the ten new foliage-plants that obtained the first prize (a gold medal) at the general exhibition of May, 1883, of the same society.—*Ed. André, in La Nature.*

THE WATER CALTROPS.

TRAPA NATANS, the subject of the annexed illustration, is an interesting plant for the indoor aquarium, or for a

FRUIT OF TRAPA NATANS.

warm tank out of doors. At Glasnevin I have seen it doing well outside the Victoria house, where it had the advantage of growing in water which came from the tank inside. Without such an advantage as this it grows best under glass in our climate; it merely requires a tub of water with soil at the bottom, which may conveniently stand on a stage in the greenhouse, or even in a stove. Being an annual, it is raised every year from seed, which unfortunately cannot always be obtained alive, and I do not remember to have heard that it has ever been ripened in Britain. The character of this plant is well shown by the accompanying illustration, but it

THE WATER CALTROPS (*Trapa Natans*).

branches and spreads near the surface of the water, upon which here and there it produces its pretty floating rosettes of leaves, each one of the latter with a swollen stalk, by means of which to a great extent buoyance is secured. Its flowers are inconspicuous, but the singular appearance of the plant is sufficient to make it always attractive. Its fruits are very remarkable; those of this species have been compared to the spiked iron instruments used in ancient warfare for strewing on the ground in order to impede the progress of the enemy—hence the name Water Caltrops. They are called Jesuit's Nuts in Venice, and in some parts of Southern Europe are ground into flour and made into bread. The seeds of all the species abound in starch, and are much used for food. Those of T. bispinosa in Kashmir are said to feed 30,000 people for five months of the year. T. bicornis has seeds fancifully considered to resemble a bull's head, and in China they also form a considerable article of food. Mr. Thiselton Dyer drew attention a short time since at the Linnean Society to a little known form of this plant called T. verbanensis. He was shown handsome rosaries made of the fruits at Pallanza, on the Lago Maggiore, where it grows plentifully and ripens its fruit by October. He was informed by Sir George Macleay that the fruits (known locally as *frutti di lago*) used for the rosaries are obtained from the Lago di Varese. It is the lobes of the calyx which harden and form the formidable projections which make the fruit remarkable. In the accompanying illustration it will be observed that there are root-like masses beneath the water, and these are finely divided leaves, which probably, to some extent at least, perform the office of roots like the submerged and root-like leaves of that charmingly pretty tropical water weed, Salvinia, which has no roots at all.—*R. I. L., in The Garden.*

DETERMINATION OF IODINE IN A MIXTURE OF IODIDES, BROMIDES, AND CHLORIDES.

By A. CAVAZZI.

FROM a mixture of chlorides and iodides the iodine can be isolated by a boiling solution of neutral ferric chloride, but if bromides are present bromine also is liberated. In order to remove the iodine alone from a mixture of the three kinds of haloid compounds, the author uses ferric sulphate instead of the corresponding chloride. It must be previously heated almost to redness in order to make it perfectly free from acid. As the calcined salt dissolves with difficulty in water a little ferrous sulphate is added, which increases the solubility and renders the solution permanent. Two grms. ferric sulphate, in presence of 0·1 to 0·2 grm. ferrous sulphate, dissolve readily in 25 c. c. of boiling water. If a mixture of chloride, bromide, and iodide is boiled with this solution, the iodine alone is separated out. The author absorbs the iodine in potassa, reduces the iodate to iodide by means of hydrogen, which is evolved in the alkaline solution by aluminum, and precipitates the iodine with silver nitrate.—*Chemiker Zeitung.*

PARATOLUIDINE SULPHATE AS A REAGENT FOR NITRIC ACID.

By A. LONGI.

IF a liquid holding in solution nitrates is mixed with a few drops of paratoluidine sulphate, and superstratified with sulphuric acid, there appears at the boundary of the two liquids an intense red coloration, which passes into a dark yellow only after a considerable time. Crude aniline may be used instead of pure paratoluidine. The red coloration can be recognized in fluids containing $\frac{1}{1000}$ nitric acid. The reaction is less sensitive than that obtained with brucine and diphenylamine, but it has the advantage of producing a different color (blue) with chloric, bromic, iodic, chromic, and permanganic acid. It can also be used for distinguishing nitric from nitrous acid, since it produces with the latter a yellow coloration which gradually passes into red.—*Gazzetta Chemica.*

A NEW CONDENSER.

DR. CARL ROTH, of Berlin, in a communication to the *Chemiker Zeitung* draws attention to a condenser lately de-

A NEW CONDENSER.

vised by him. He was led to its construction by the frequent breaking of the tubes in Liebig and Hofmann condensers, in which latter the water immediately surrounds the tube containing the vapor. While, ordinarily, there is little danger of the tubes bursting, they are, nevertheless, quite liable to do so in cases of the distillation of absorption products.

Dr. Roth's condenser, as the figure shows, consists of a glass tube around which is wound a thin lead pipe of from 10 to 15 times the length of the glass. The pipe is first wound with the convolutions close together, and is then brought back in large turns as shown. This arrangement allows the water to be heated somewhat before it gets close to the glass, and in addition it utilizes to a greater extent than in the old form. Its efficiency can be increased still more by placing tin foil upon the glass before winding the tube. Another advantage of the apparatus is, that in case the glass tube bursts, the distillate will not be in danger of becoming mixed with water.

Dr. Roth states that he has used this form successfully in experiments that would inevitably have caused the destruction of Liebig's condenser. In the figure the water enters at Z and flows out at A.

THE ELECTRO DEPOSITION OF NICKEL.

By H. FONTAINE.

FOR the baths M. Gaiffe gives the following formula:

Nickel and ammonium, double sulphate.	1 kilo.
Distilled water	10 liters.

M. Roseleur prefers to take:

Double sulphate	400 grms.
Ammonium carbonate	300 "
Distilled water	10 liters.

Each of the two salts is dissolved separately in a part of the water. The solution of ammonium carbonate is gradually poured into that of nickel, taking care not to pass the point of neutrality. The quantity of 300 grms. of ammonium carbonate indicated above is not obligatory, but may be varied according to the quality of the salt of nickel. M. Adams proposes the two following mixtures:

1. Chloride.—Take 135 grms. pure nickel, and dissolve in hydrochloric acid, avoiding excess, and heating gently. When all is dissolved, add 2·25 liters of cold water, and add gradually ammonia until the liquid is neutral to litmus paper. Dissolve separately 70 grms. sal ammoniac in water, and mix with the former solution, and make up to 10 liters with cold water. 2. Sulphate.—Dissolve 135 grms. of pure nickel in sulphuric acid diluted with twice its weight of water, and heat until the metal is dissolved. Add v[illegible]ize with ammonia. Dissolve separately 70 [illegible]um carbonate, and neutralize the solution c[illegible] sulphuric acid. Add this liquid to the sulphate of nic[illegible] and make up to ten liters with cold water. In both cases filter the liquids or dilute after standing. M. Adams ascribes a good deposit of nickel to the absence of potassa or soda, while in reality excellent deposits may be obtained in ammoniacal baths containing salts of potassium or sodium.

ESTIMATING THE ACETIC ACID IN WINE.

DR. LANDMANN has improved on the processes hitherto in use for distilling off the acetic acid from wine so as to estimate its quantity. He puts 50 c. c. of the wine in a flask of six times that capacity, and adds as much tannin as will lie on the point of a knife blade to prevent foaming. This flask is fitted with a double bored cork through which pass two glass tubes. One of these reaches nearly to the bottom of the flask, and is connected with a second and rather larger flask in which steam is being generated. At the lower end, where it dips in the wine, this tube is somewhat contracted. The second tube has a bulb just above the cork, then bends twice, and connects with the *upper* end of a Liebig's condenser placed vertically. The liquid in each flask is heated to boiling, then the flame under the wine flask is made quite small, and the steam passed through the wine until 200 c. c. of distillate are obtained, which does not require over 45 minutes at the longest. This distillate contains all the acetic acid in the wine, and being the only volatile acid there, may be easily titrated.—*Z. Anal. Chem.*, xxii., 516.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
261 Broadway, New York, N. Y.

TABLE OF CONTENTS.